

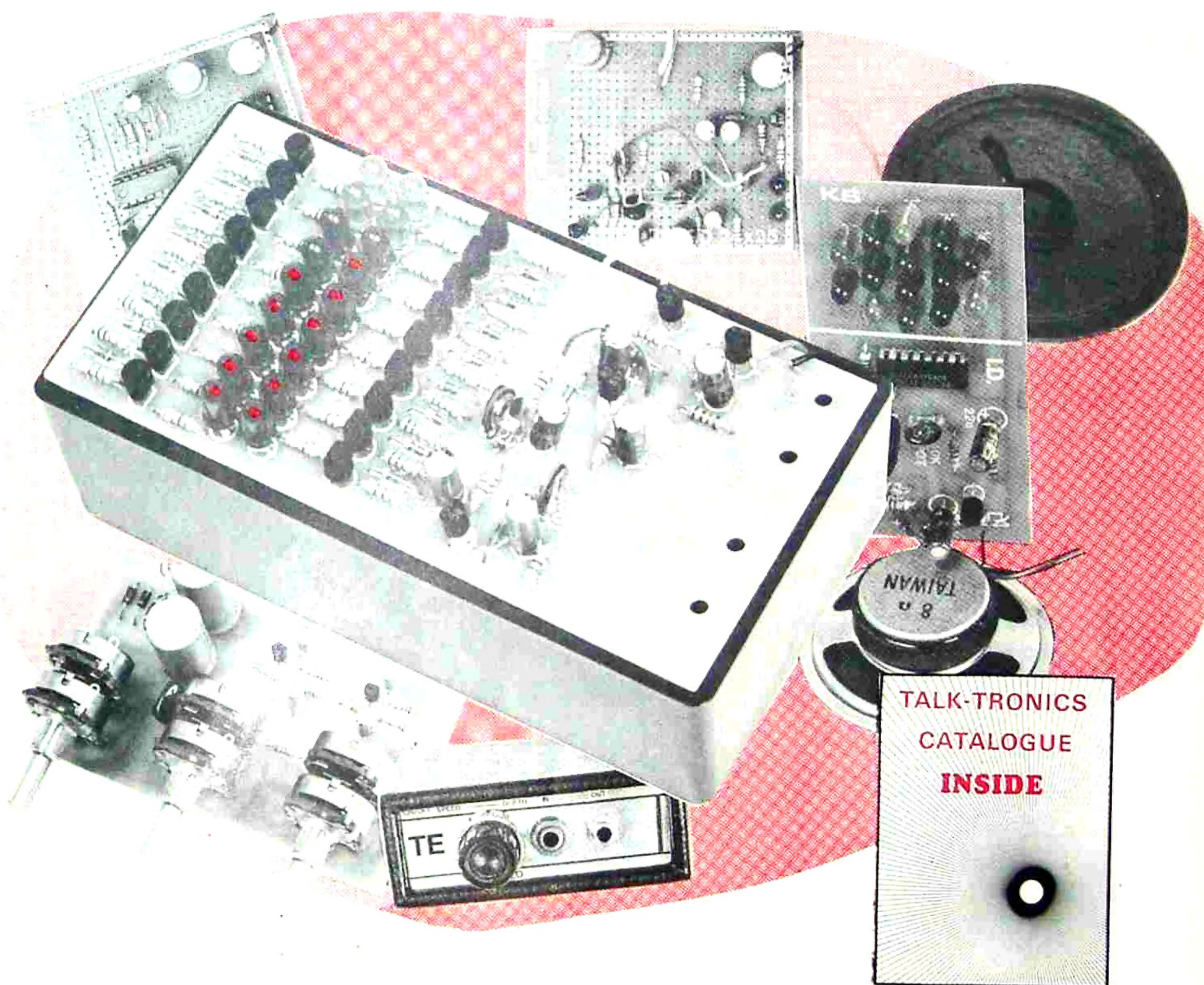
# TALKING ELECTRONICS®

THE MAGAZINE THAT SPEAKS FOR ITSELF

**\$3.75** ★

N.Z. \$5.00

## Issue No 7.



TALK-TRONICS  
CATALOGUE  
**INSIDE**



# TALKING ELECTRONICS

**Editorial...**

**Vol. 1. No. 7.**

They said it wouldn't work.

When I first approached printed circuit board manufacturers with an order for 20,000 printed circuit boards, they laughed "What! you're going to put them on 20,000 magazines!"

They did not want to know about the feasibility or the economics or the practicality, they just didn't want to know. So we went it alone.

From the outset, putting a PC board on the magazine was a resounding success. . . . Now their attitude has changed. Even with the HANGMAN and its limited appeal, the response has been most gratifying.

This month we have a STEREO VU METER. A handy piece of gadgetry which can be adapted from its original use to display decibel sound levels in noisy surroundings or become an LED VOLTMETER for low voltages. Next issue we are planning a DIGITAL CLOCK with an antenna capable of picking up stray 50Hz mains frequency in the air. You will have a choice of using a plug pack for constant display or a battery version using the antenna.

(It's still in the planning stage - it's designed as a Study Clock. You'll learn what we mean in the next issue.)

TE is necessary reading in many schools where it is beginning to have an impact on the type of material being taught.

Eventually we hope to prepare a Syllabus for the teaching of DIGITAL ELECTRONICS at junior level. From this we can follow through to higher levels. But we have to start at base level. The impact of digital operations has not yet entered the Education system and yet we are playing with \$40 talking toys!

If this is not introduced poste haste, our electronics graduates will be unfamiliar with digital designs.

We will start by requesting further syllabii from teaching institutions and if you are currently following an electronics course containing digital operations, you will help us if you send in a copy of the topics being taught. This will get the ground-work started.

Cheers,

## TECHNICAL

Colin Mitchell

*Colin Mitchell*

## ARTWORK

Ken Stone

## ENQUIRIES

10 Minute queries will  
be answered on 584 2386

## ADVERTISING

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## Publisher

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OUR COVER shows  
an array of this  
month's projects.  
The STEREO VU  
METER is a real  
winner!

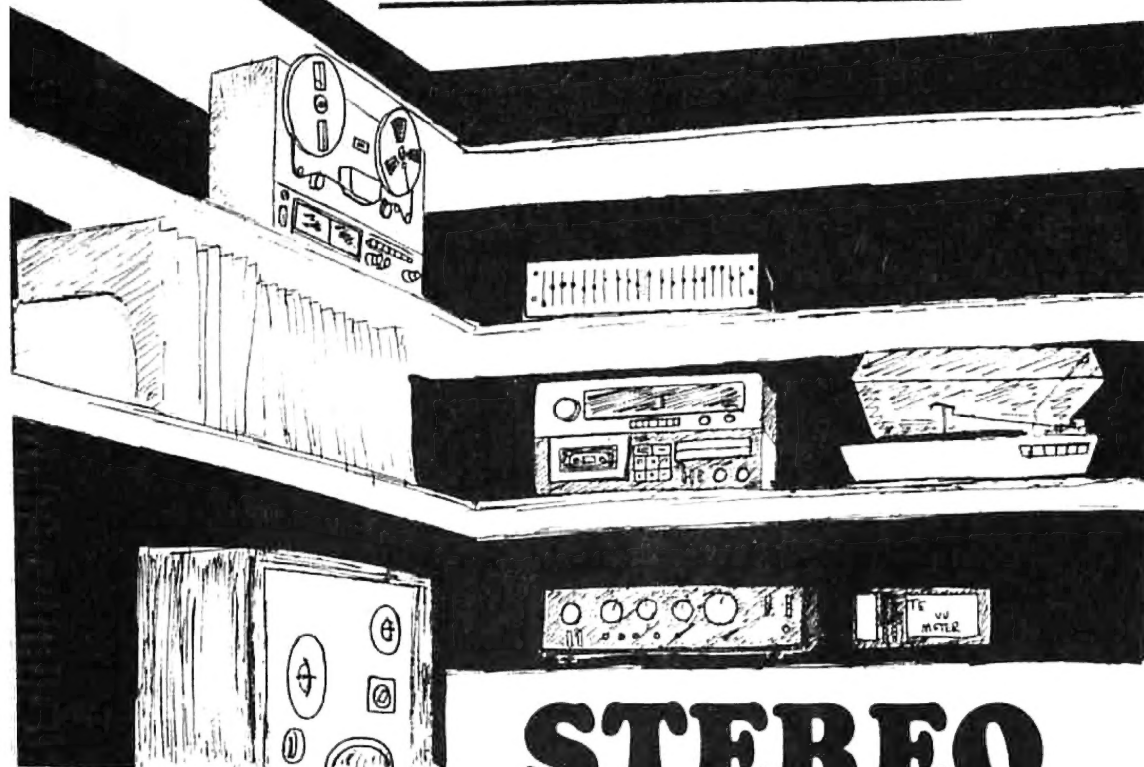
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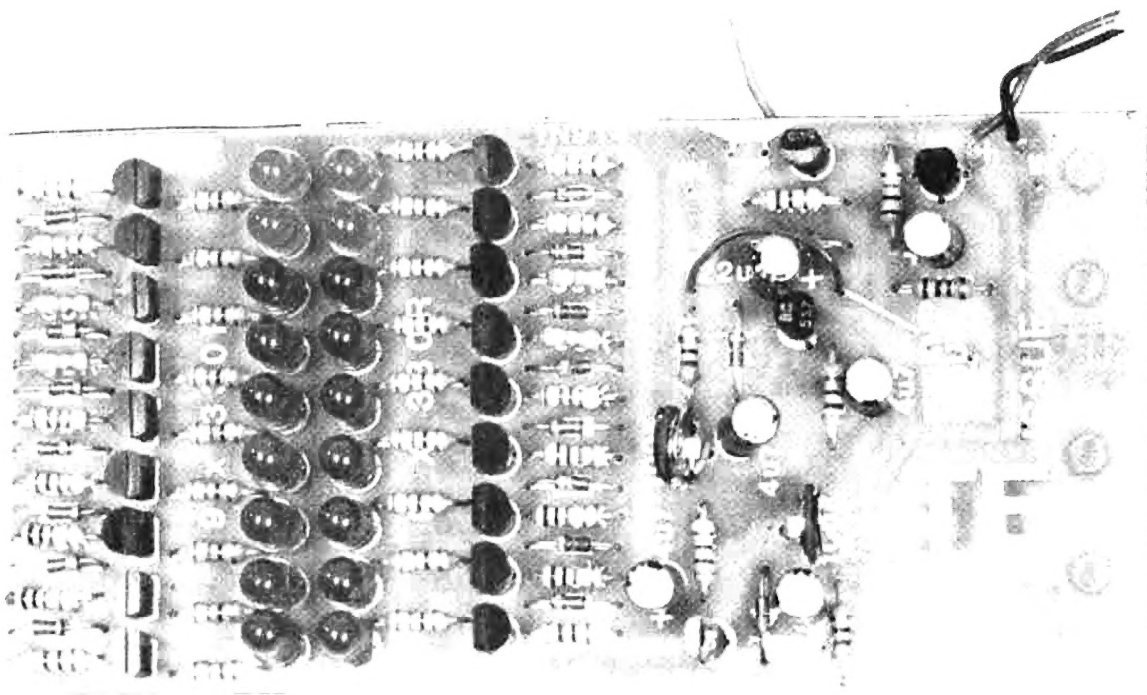
## OUR COVER FEATURE



### Before you begin:

Check the PC board attached to the magazine to make sure all the holes have been drilled and inspect the underside for very narrow gaps between the tracks or even lands which touch. This is mainly in the BOOTSTRAP section.

# STEREO VU METER



*The completed unit in close-up. The overlay makes construction easy. Make sure the left-hand row of resistors starts with 47k at the bottom and 4k7 at the top. I saw one unit with the whole row reversed. It made very little difference to the performance of the unit, but it was not quite as sensitive as the correct version.*

**Use the attached PC board to make this self-contained VU meter. It can be used 2 ways:**

- 1. With its dynamic microphone pickup, or**
- 2. Connected to the speaker leads of a stereo.**

**Either way, it produces an interesting effect and all the components are readily available.**

Does your amplifier have a level indicator?

Have you always envied the fancy amps with LED level bar graphs?

Would you like to build your own STEREO LEVEL INDICATOR?

Pine no more, it's here. Our feature project this issue will suit all audio buffs. It is a STEREO LED LEVEL METER. It's the cheapest and best bar graph display available and best of all, it uses readily available components.

You only need a handful of LEDs, 22 transistors, some resistors, diodes and a set of electros - it doesn't require any chips.

You may be wondering why we didn't choose the LM 3914 or LM 3915 bar-graph LED driver chips. The reason is simple. We learnt our lesson from the Mini Frequency Counter book. In this project we used a relatively novel chip, the CD 4026. And after releasing 10,000 copies of the magazine, with printed circuit boards attached, the chip became almost unobtainable in Australia. This proved to us that many of the readers were making the Mini frequency Project. Now, a chip such as the LM 3914 is scarce at the best of times. Can you imagine what would happen if we used it in a project? Ninety per cent of the readers would miss out. This means we must confine our projects to readily available components and avoid rare items, no matter how inviting they look.

We compared a LED level meter using the chip with our unit and the difference was negligible. Both had the same quick response-time and about the same readout values on the line of LEDs for the same input signal. But the big difference is in the cost of construction. By using transistors, you will save \$4 over the cost of two chips. If you don't mind the additional time required to fit the extra components, the \$4 is a valuable saving and by using discrete components, you can build it from parts you may already have in stock.

#### THE CIRCUIT

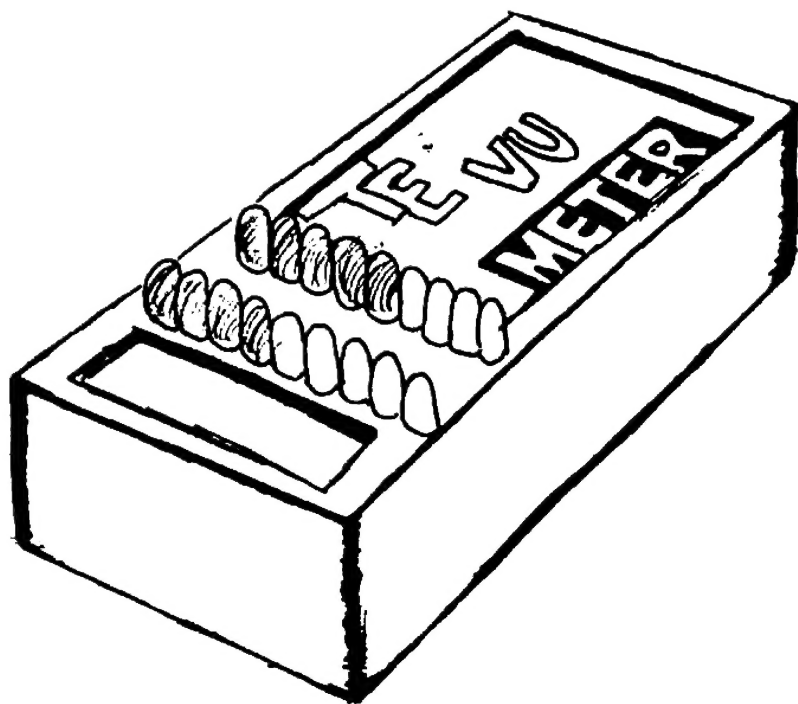
The circuit basically consists of two identical channels feeding two rows of LEDs. A high-gain bootstrap front-end is also provided to allow the board to be coupled to an inbuilt speaker/microphone which will give a mono readout of the sounds being picked up.

#### TO THE HI FI BUFF:

*This is a fun project. It is not intended as a piece of test equipment or as an accurate reference source. Its sole performance is to provide a visual indication of an analogue signal. So don't expect too much.*

*Although you could continue further and calibrate the unit in dB, we have particularly stayed clear of any complex calibration as we do not think it is warranted. We hope you will use it in an open situation where the sensitivity can be adjusted so that the top LED is energised during the loud passages and the display shows 5 or 6 LEDs for the majority of the time.*

*Used correctly, it will add interest to your stereo by displaying the relative channel separation and highlight the peaks being produced. With its fast response-time, it will give a more accurate readout of the passage than a VU meter and will be much easier to read when comparing two channels.*



*By using a larger Zippy box, you can mount the board inside the box and allow the LEDs to protrude.*



# STEREO VU METER

A mini trim pot is provided to set the sensitivity. This makes the project completely portable and it can be used as a **SOUND LEVEL** meter in a disco or other noisy situation. To give a readout in dB it would require calibration. The simplest method of calibration would be to compare it with a commercial unit and give each LED a value in dB.

By providing another bootstrap circuit, a portable stereo sound detector could be made. This could compare sound level in different parts of a room or compare the relative outputs from 2 speakers.

As designed, the stereo section needs to be wired into the output of each channel, across the speaker terminals, and the unit mounted in some prominent place for an eye-catching display.

Before you begin. Lay the components on the work-bench in a position relative to that on the PC board. Some of the parts have the same value, such as the 330R resistors. These should be positioned on the board with their tolerance bands all round the same way. Separate the two BC 557's from the other two transistors and be sure you can identify the 22mfd electrolytic from the 4.7mfd.

The board looks deceptively simple because most of the components are placed in rows. It will take at least one and half hours to construct the project and the most important facet throughout construction is to create a neat appearance. This means aligning each component with the next and keeping the heights all the same. Otherwise the neat appearance will be destroyed.

The suggested method of construction is to start with the resistors and diodes. These should be inserted alternately as required by the board so that you have maximum room when placing them in position.

Slow and sure wins the race. It is best to insert the parts one at a time and push them firmly onto the board. Nothing looks worse than a mass of floating components, some high, some bent this way, others bent the other way. Once you push them onto the board, bend their wires outwards so that the component is held in position. Turn the board over and solder the two connections quickly. Check that the component has not shifted then snip the two wires. Continue down each row, taking one item at a time.

If you find that you are closing over some of the holes with solder when you are soldering, I suggest you only tack-solder the leads and wait

for the other component to be inserted, before finishing the joint. Tack soldering is very fast and requires almost no solder. This prevents the solder flowing over the land and filling up the remaining holes.

You may have noticed that the two channels are a mirror-image of one-another. This means the cathodes of the LEDs face outwards and before inserting each LED you should look into their opaque body to make sure they are being inserted correctly. In our prototype, the two top LEDs of each channel are a different colour, mainly to add interest to the display. You may choose to add another colour for the bottom two or three LEDs and produce an even more exotic display.

The driver transistor for each channel and the bootstrap circuit fit onto the right-hand portion of the board. All the component values are identified and the two BC 557's are shown as 'FILLED IN', whereas the BC 547's are open 'D's'.

There are no jumpers on the board. However we have made provision for connecting the bootstrap circuit to either one or both channels via one or two links. These links are taken from the 'pre-amp OUT' point to either the left hand channel or the right hand channel.

## PARTS LIST:

- 18 - 33R
- 2 - 470R
- 1 - 1k
- 1 - 2k2
- 5 - 4k7
- 5 - 10k
- 2 - 22k
- 2 - 33k
- 4 - 39k
- 4 - 47k
- 4 - 4.7mfd 16v PC
- 2 - 22mfd 16c PC
- 20 - BC 547
- 2 - BC 557
- 18 - IN 914 or IN 4148
- 14 - 5mm red LEDs
- 4 - 5mm green LEDs
- 2 - 100k mini trim pot
- 1 - battery snap
- 1 - speaker 8 ohm
- 1 - VU METER PC board

## HOW THE CIRCUIT WORKS

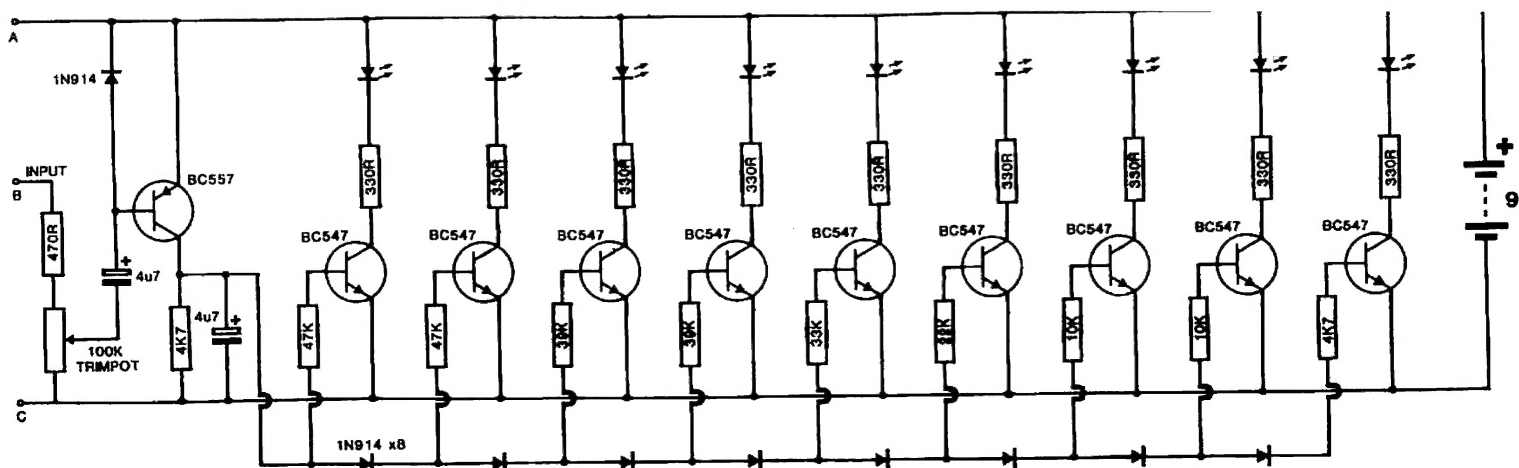
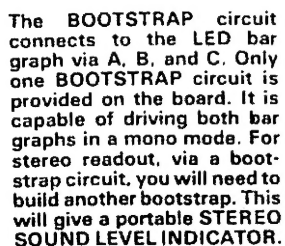
1. BOOTSTRAP CIRCUIT
2. BUFFER TRANSISTOR
3. STAIRCASE VOLTAGE DETECTOR

The **BOOTSTRAP** is rather unique in its operation. It uses 2 directly coupled PNP transistors wired in a similar mode to cascade to give an enormous voltage gain. In our prototype we measured this to be about 1,000 times!

Take the case where the speaker produces 2 millivolts which is in phase with the quiescent voltage and this will turn the transistor Q1 slightly off. The collector voltage will rise and in doing so, take the base of the emitter-follower Q2 with it. Under normal circumstances, the collector voltage would rise about .2v. for Q1. This will make the emitter voltage of the emitter follower rise .2v (which is normal for an emitter follower). Now the top 22mfd electrolytic will transfer this .2v to the join of the 10k and 2k2

**The BC 557 is not an emitter follower. Don't get confused. It is wired as a normal common emitter stage for a PNP transistor. Thus it will**

The set of 330R resistors limit the current through the LEDs to a safe value and the base resistors serve as a voltage dropper so that the base will not be forced to go higher than .6v. The number of transistors which can be operated in this staircase arrangement is limited to the battery voltage available since each transistor and diode will take .6v from the voltage supplied by the BC 557 buffer transistor.





# STEREO VU METER

## TESTING

To test the stereo VU meter, connect the two links as shown on the board and connect the dynamic microphone (speaker). Solder a battery snap to the board and connect a 9v battery. This project is now a self-contained level meter and will give a dual readout of the sound detected by the speaker. We are using a small speaker as a microphone as we have had a great deal of success with its sensitivity. No calibration is required. You only need to position the pick-up (spkr) near a radio or stereo which is playing at normal listening level and adjust the sensitivity controls. These are the two 100k mini trim pots in the buffer stage. First you must set each one so that the top led is just illuminated when a loud passage is being received. Then you need to trim the two displays so that they produce equal readouts for the same information.

## FAULT FINDING

Since each channel is identical, you will be able to reference off one channel to repair the other.

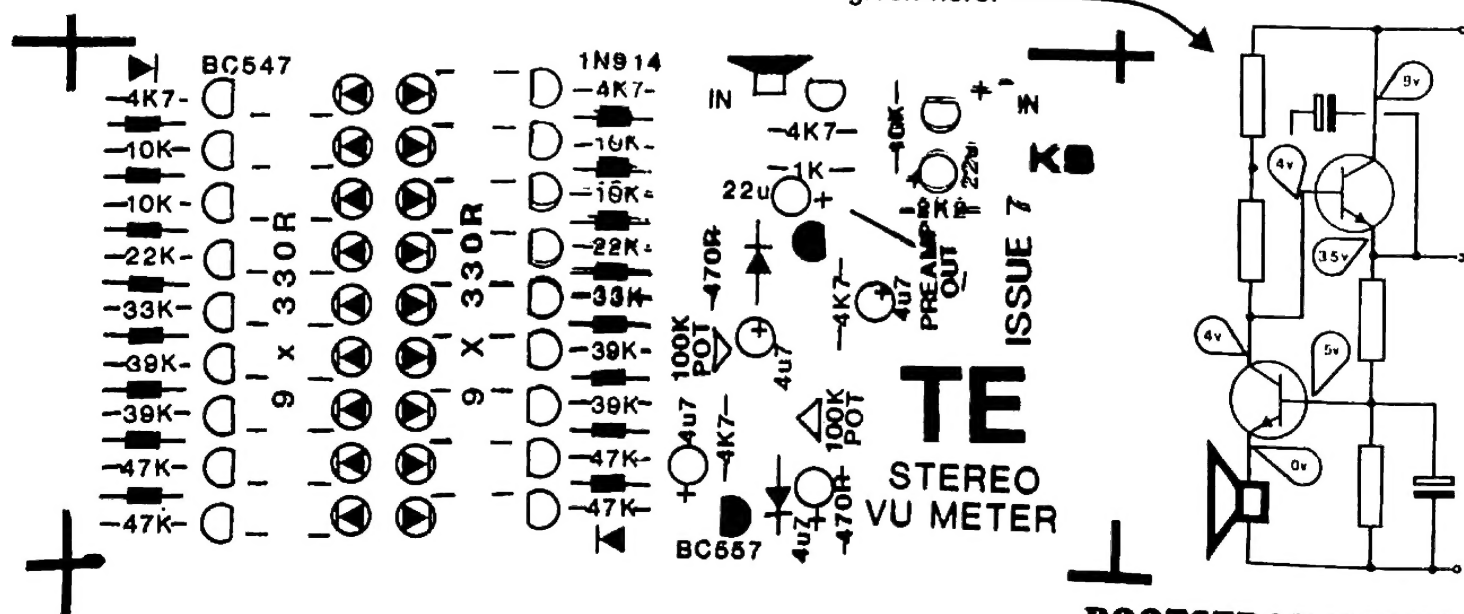
The chain of transistors are all DC coupled and you can test their operation by using a 10k resistor connected to a set of jumper leads. Connect one jumper to the positive of the

battery and touch the other onto the cathode of the lowest diode in the staircase. You cannot do any damage to any component when probing around either channel and I suggest you take this opportunity of seeing the effect of a turn-on voltage when applied to a set of transistors.

When the 10k resistor is touched on the cathodes, almost all the LEDs should light up. By moving the resistor up the chain, the top LED will light. This will show the channel to be functioning and you should test the other channel for the same effect. If one LED fails to light, you may have a base-emitter short in one of the transistors or the LED itself may be faulty. If any LEDs above number 6 fail to light, one of the diodes may be open or a dry joint may be the cause.

If you have trouble getting one channel to function, you can use the components from the other channel as test pieces. This is the great advantage of having two identical channels. But by using parts from the good channel, you could finish up with two bung channels. That's the risk you take.

The buffer transistor can now be tested by connecting the 10k to earth and touching the other end on to the base of the BC 557 transistor. This will illuminate one complete row of LEDs. The remainder of the circuit is AC coupled via the 4u7 electrolytic. Only the DC conditions of the bootstrap section can be tested with simple equipment. Use a multimeter to detect voltages similar to those given here:

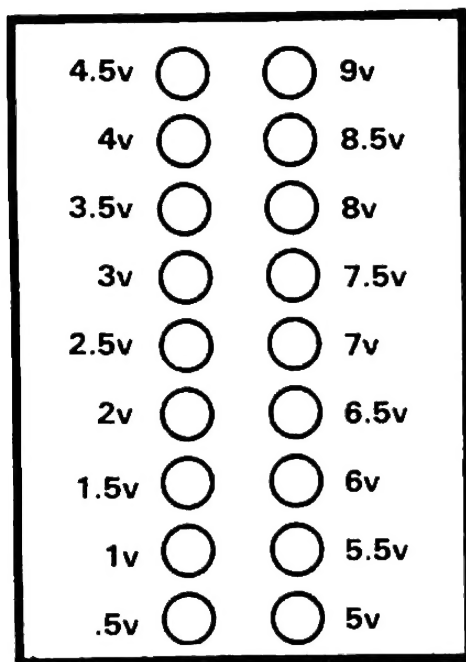


**THE OVERLAY:** Eventually you will be able to construct our projects using only the overlay. If you are unsure, follow through the notes.

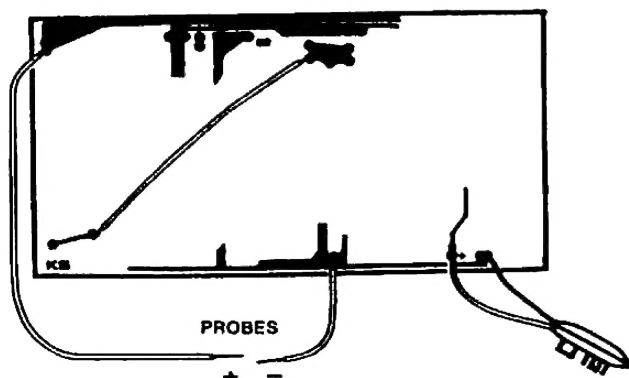
Both transistors will be turned on very slightly and because it is a very high gain circuit, you cannot remove one transistor and hope to get a smaller amplification. It will completely fail to work.

# 0 - 9v

## LED VOLTMETER



**SCALE FOR LED VOLTMETER**



*Underside of the VU meter board showing how to cascade the two rows of LEDs. The positive and negative probe leads are shown connected to the board. You will also need a 6v or 9v battery to supply power to light the LEDs.*

If you already have a VU meter, maybe you would like to build this LED VOLTMETER. It uses the VU METER board and requires only those components driving the two rows of LEDs.

It is often handy to have a voltmeter on the work bench to test low voltages without tying up the multimeter.

The STEREO VU METER can be converted into a 0 - 9v voltmeter very easily.

Since the staircase of transistors are all DC coupled, they can be used to display voltages from .5v to 9v.

To make the LED VOLTMETER easy to read, we have allocated each LED with a voltage increment of .5v. This proved to be on the safe side by less than .25v for a full-scale reading and was quite accurate through the range.

Now you can test your battery packs and lantern batteries under a slight load and get an accurate assessment of their voltage. This voltmeter has a medium sensitivity equal to 10k ohms per volt and draws only 1ma from the voltage being tested. You will still need to have a 6v or 9v battery to drive the row of LEDs, but this circuit will only draw power when the LEDs are showing a reading. It will shut down to almost zero and conserve the battery after a measurement has been made.

To produce a range of 0 to 9v in .5v increments, we are using the two rows of LEDs in cascade. This means the end of the first row is connected to the beginning of the second.

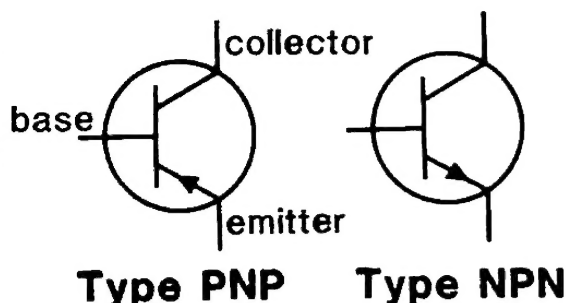
Refer to the layout diagram for the jumper link. You will not require any of the bootstrap section or the buffer transistors for this application and they can be removed from the board. If you wish to remove only the minimum of components, both the 557 transistors, the 4k7 load resistors and the 4.7mfd storage electrolytics should be removed. The remainder will not inhibit the performance of the circuit.

No extra parts are required except two lengths of flex to act as test leads. Use a red lead for the positive and a black lead for the negative. When testing a voltage, it will not damage the meter if the leads are reversed. The LED display will just fail to light.



# DESIGNING WITH TRANSISTORS

by Colin Mitchell



Many readers have expressed a desire to catch up with transistor circuit design before launching into IC's. It's nice to master the early stages of learning before branching out into something more involved. Let me say at the outset, that the theory behind even the simplest transistor stage could fill a magazine twice this size. It's that complicated. To simplify the theory, to its barest essentials, I have omitted any mathematics and have taken a very simple approach to explaining some of the terms. This will introduce some unfounded approximations and 'rules-of-thumb'. Designers quite often work with empirical formulae which are generally simplifications of complex mathematical equations. They can also be facts gained from numerous similar circumstances and in this case the knowledge comes from the dozens of circuits I have constructed and designed in the past few years.

This article is mainly intended to give you an insight into a designers thinking when he is required to design a small-signal stage. Up to now, the circuits presented in TE have been mainly digital and the only role for transistors has been as a buffer stage or as a low signal stage. This situation will still be maintained. The logic stages will be left to IC's, where they are more suited and a lot cheaper. Imagine connecting 20 or 30 transistors and lots of resistors and capacitors on to a bread-board to take the place of a 30C IC! It would be impractical. So, for the main part it's ICs. And for a fill-in, we use the humble transistor.

Our aim has been to bring the digital circuit to the fore-front and give it the exposure it deserves. For low-level amplification, a single transistor can perform equally as well as an op-amp. However, at the moment, constructors are more likely to accept a transistor and its associated resistors than an 8-pin op-amp chip. This will change in time but for the moment constructors are still thinking along the lines of being able to use up some of the components they already have in stock.

Maybe you are in this position. Nearly everyone has an assortment of PNP and NPN transistors they want to utilize. And with a little knowledge of circuit design, they can be introduced between an analogue device and an IC. This will increase the amplitude of the signal sufficiently to drive a logic gate. We have already employed a single transistor amplifier stage in 3 of our circuits, where it has been expedient to do so. These circuits are: the SHOOT GAME, in issue 4, COUNTER MODULE sensors in issue 5 and HANGMAN in issue 6. Look at these circuits and familiarize yourself with the parts and their values.

In this article I will be dealing with a silicon NPN transistor placed in a common emitter circuit. Figure 1 shows a COMMON EMITTER CIRCUIT.

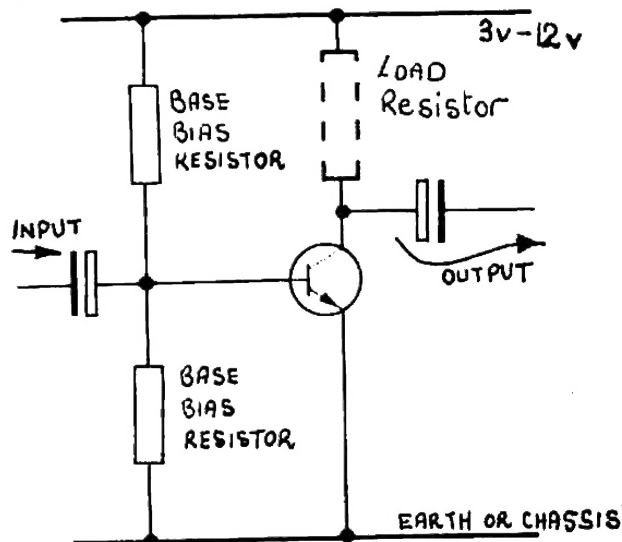


fig. 1.  
**COMMON EMITTER AMPLIFIER**

It gets its name from the fact that the emitter is connected to GROUND or EARTH and this is sometimes called COMMON or CHASSIS or FRAME or DECK. They all mean the same. In this configuration the transistor has medium input impedance and high output impedance. This produces a stage with high current and voltage gain giving a high power gain. Thus this stage is very often used in amplifiers.

You will notice we have used a capacitor in the input and output. This allows our discussion to revolve around this stage as an entity and we will not be concerned with any voltage levels in the previous stage or the following stage as far as the quiescent or standing condition is concerned. The word STAGE is the same as BUILDING BLOCK and vice versa.

A transistor having a capacitor at the front end and the output is called capacitively coupled. Removing the capacitor creates complex coupling problems and this will be dealt with later.

For simplicity we will deal with only the common emitter stage with inter-stage coupling.

Now, one of the fundamental problems with transistors is their sensitivity to heat. Because of this, a considerable amount of thought has to go into designing the components around each transistor so that the amplification of the stage will remain constant for a wide temperature range. Also the slight variations between one transistor and the next, must be compensated for, in the design. Designing around these features is loosely called STABILIZING. According to the amount of stability required, the number of bias resistors will range from one to three. This gives us three slightly different circuits.

See circuit 1 (fig. 4.) circuit 2 (fig. 5.) and circuit 3 (fig. 6.)

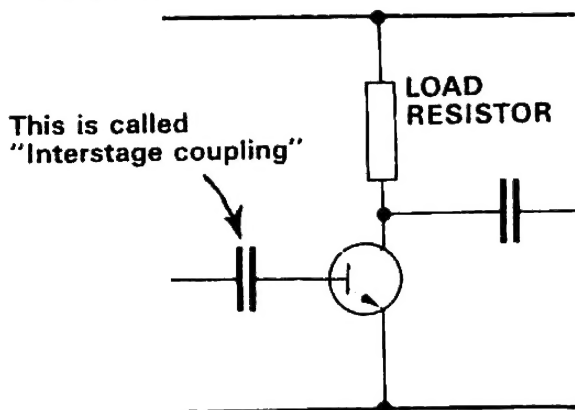


fig.2. NPN transistor with load resistor  
**STABILIZING**

Let us start with no stabilizing resistors. The resistor shown in figure 2 is not a stabilizing resistor. It is a load resistor. Stabilizing is employed around the base and emitter leads. If you don't use any stabilizing resistors at all, as **as shown in figure 2**, the circuit will not work properly. If a signal is fed into the base, it will appear at the collector in a distorted form. This is due to the transistor not being turned on in its DC condition. This simply means the base must have a slight DC voltage on it so that the input voltage can add to this voltage or detract from it to give an output which is an amplified version of the input. Without a bias on the base, the only portion of the signal which will be amplified is the portion which would normally ADD to the base voltage. This is the positive part of the waveform and will produce a positive voltage on the base. The negative portion will be lost completely. Thus the resulting sound out of this stage will be clipped or distorted.

To turn the transistor ON, we need a resistor or a pair of resistors. There are three possible biasing

arrangements: Let's look at the first:

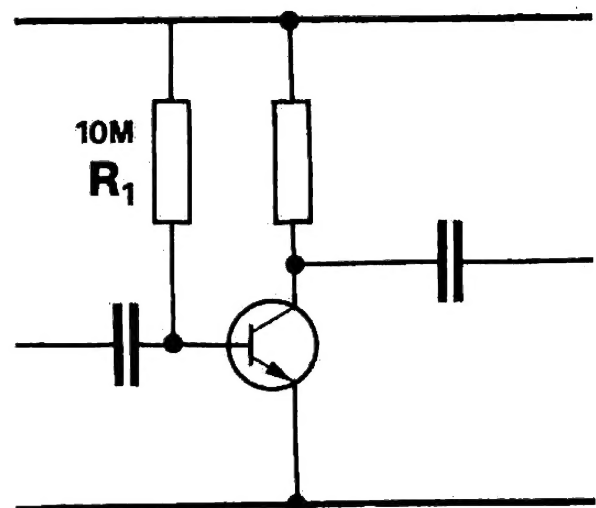


fig 3 NPN with base bias

To operate successfully, a common emitter stage must be correctly biased. This means setting the base voltage to about .6v so that the input voltage can operate the transistor just as effectively in the positive direction as the negative direction.

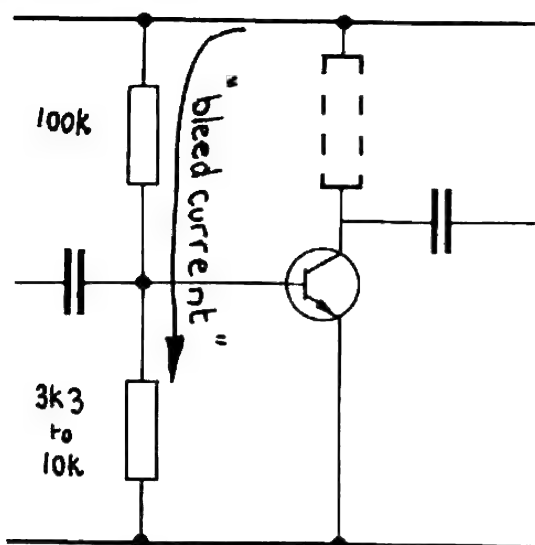
*In our discussion, .6v on the base does not turn the transistor on HARD.*

*.65v turns it on hard and about .55v turns the transistor OFF - it's that critical. ON HARD is the same as BOTTOMING or SATURATION. OFF is called "CUT-OFF".*

Obtaining .6v on the base is a very difficult job. It may look easy, but transistors are very sensitive to temperature and a voltage of .6v may be present when the transistor is cold, but this will alter when the transistor heats up or is influenced by hot surroundings. And a voltage of only .05v higher or lower than the required .6v will completely change the operating conditions. So let's see one possibility as shown in figure 3. The value of R1 is calculated according to the current flowing through it. Now silicon transistors have a very LOW base-emitter leakage and so the value of R1 must be very high (in the range 1M to 10M), to give a voltage of not more than .6v on the base. With a feeder resistor such as this, we have no way of stabilizing the base voltage with temperature change. As the transistor gets hotter, the base-emitter leakage increases and the voltage changes. Also the natural spread of parameters for any batch of transistors will alter the base bias.

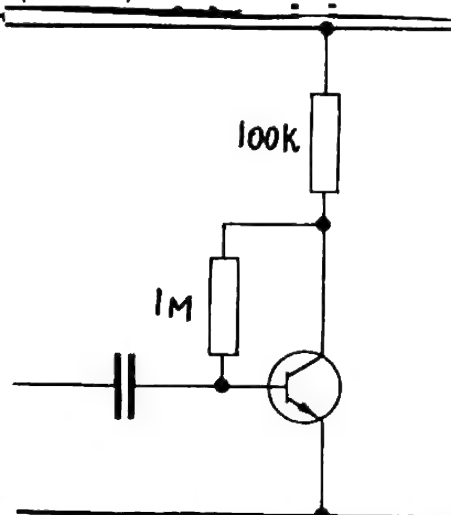


What we need is some form of biasing which will automatically keep the voltage somewhere near .6v. This is achieved in the bridge network



**Fig. 4. NPN WITH BASE BIAS RESISTORS**

shown in figure 4. The base bias resistors pass a small current which is called a "bleed" current and should be about 10 times the base leakage current. As the transistor temperature rises, the base current increment will have little effect on the voltage drop across the resistor. The base-emitter resistor (the lower resistor) is generally about 3k3 to 10k for this type of circuit. Let us choose 6k8. We have mentioned that the base leakage is very small (about 10%) and will not concern us. If .6v is to be dropped across the 6k8 resistor, we will need 100k for the top resistor. This will give us a bleed current of .01mA but more importantly, the base will be set to very



**Fig. 5. NPN WITH "SELF-BIASING".**

nearly .6v. If the voltage were to fall to .55v, the transistor would turn off and if it were to rise to .65v, the transistor would be turned on hard. Under these two conditions the stage would not

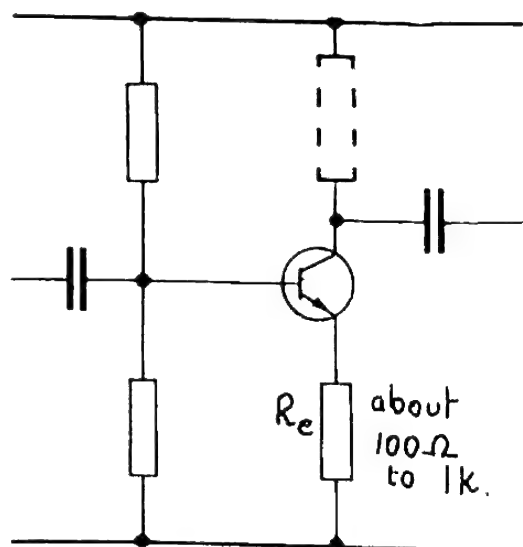
work at all, so the .6v must be closely maintained. And this very small voltage range is very hard to achieve. To do it, we can employ one resistor placed in a very clever position.

Figure 5 shows the position. This arrangement is called 'self-biasing' and although the resistor is nearly as high as the value used in figure 3, it has a much better effect on biasing the transistor. It works like this:

Before the resistor is inserted, the collector voltage is near rail voltage so that when the resistor is connected in place, it turns the transistor on. This reduces the collector voltage and in turn reduces the base voltage.

An equilibrium is soon set up which does not allow the transistor to be fully saturated. (turned on). Any rise in temperature sets a new equilibrium point very near the original condition. This is the cheapest and best method for biasing. And it works very well. This arrangement is generally confined to the first transistor stage in an amplifier, where high impedance is required and very small signal conditions are present. It also offers very low bleed current.

But is not suitable for the second stage of amplification where higher current signals are present.



**Fig. 6. BRIDGE NETWORK FOR BIASING**

For the second stage in an amplifier we will have to use the circuit shown in figure 6.

This circuit is called a bridge circuit with emitter feed-back. The resistor in the emitter will usually be fairly low resistance - from 100R to 1k but even at this low value, it will have a dramatic effect on the gain of the stage. It will also provide very efficient stabilizing and will enable a wide range of transistors to be used with the one set of resistors. This is because each transistor will

settle down into its own biasing situation to give a fairly similar gain to any other transistor in the batch.

The emitter resistor provides considerable negative feed-back and this is most noticeable when a signal is being processed. The voltage across the resistor is due to the emitter current and this voltage is reflected back to the base to reduce the base-emitter voltage. This action will have the effect of turning off the transistor. The base voltage-divider is arranged to provide a higher forward bias than in the previous example to compensate for this feed-back effect. In operation, any tendency for the emitter current to increase will increase the voltage drop across  $R_e$  and this results in an automatic reduction in the base-emitter voltage to counteract the original rise. This is most noticeable with an AC signal. A .1v input signal will increase the emitter voltage by more than .1v due to the amplification of the transistor and this will offset the original amplitude. Thus this circuit will not amplify AC signals very effectively. To improve its performance, we add a capacitor across the emitter resistor. This capacitor should range from 1n to 100mfd depending on the frequency being amplified.

## COMBINING STAGES

Let us look at combining 2 of the stages we have covered.

Figure 7 shows 2 separate stages which are capacitively coupled. The first stage is a low level amplifier and maintains a self-bias condition via the 10M resistor.

**The output appears at the collector and this is amplified by the second stage.**

The 10n capacitor serves to separate the two stages since the DC operating conditions of the first transistor is different to the second. To make this clearer: The collector of Q1 is about 3v while the base of Q2 is about .75v. The AC signal will pass through the capacitor with only a small signal loss, but the DC will be blocked. The gain of the first stage will be about 40 and the second stage about 20. This gives a total gain of about 800. Theoretically the output would drive a loudspeaker but we find in practice that the volume is rather low. You would need a further stage of amplification to increase the volume to a listenable level.

A 100mfd electrolytic has been added across the

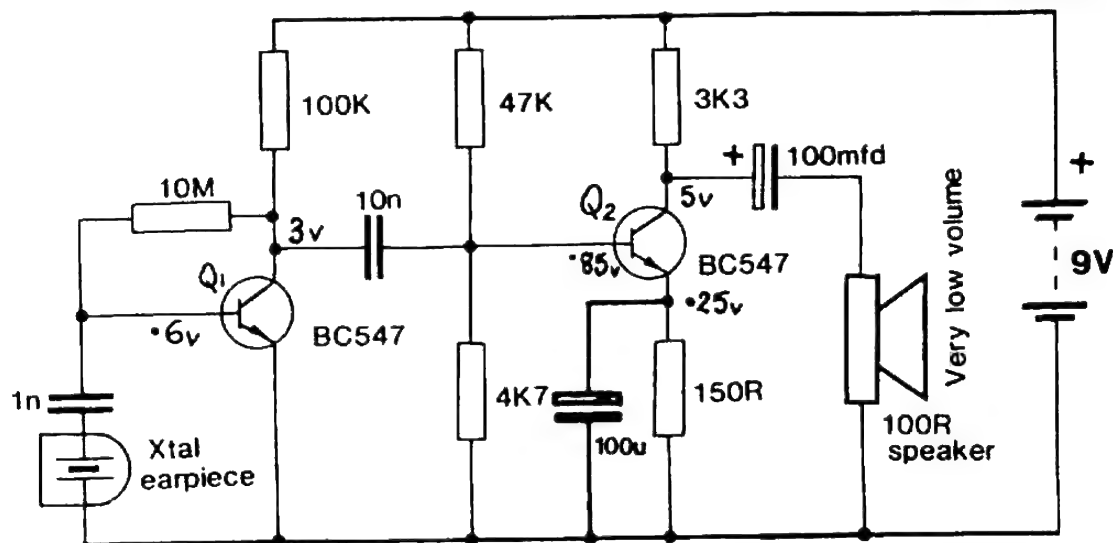


Fig. 7. COMBINING TWO STAGES TO MAKE AN AMPLIFIER

### LOAD RESISTOR

The resistor in the collector is called the load resistor. Its value will depend on the power gain of the circuit. This resistor should be as high as possible to reduce thermal noise, especially in pre-amplifier stages. This also keeps power losses to a minimum. The first transistor in an amplifier will be handling very small signals and the load resistor will range from 10k to 100k. When operating from a 9v supply, the collector voltage will be only about 3 - 5v. In fact, the collector voltage can be as low as 2v and still give a high gain (when using a high impedance source such as a crystal microphone or cartridge).

150R resistor. This increases the AC gain of the stage dramatically. It can be likened to a shock-absorber in a car. Its purpose is to keep the .25v constant on the emitter of the transistor when an AC signal is being amplified. If it were to be removed, the AC signal appearing at the base would create a voltage drop across the emitter resistor which would equal the input voltage and thus the transistor would not see a voltage differential between the base and emitter leads. The electrolytic has the effect of slowing down the emitter voltage rise just like trying to stretch or pull a shock-absorber. It will respond, but only slowly.



The net effect is for the emitter voltage to remain as in the DC state while allowing the AC signal to be amplified.

None of the components in the circuit are critical and you may even like to build the circuit to see how it performs. The only problem will be a 100R louspeaker. You can use any impedance between 33R and 100R but if don't have one of the high impedance speakers, don't buy one specially. We have better amplifier circuits in other parts of the magazine.

From the circuit diagram you can see it uses 5 components for the stabilizing. The remainder of the components provide load and stage separation. Even this number of components can be reduced if we directly couple the two transistors. To do this we cannot just remove the stage-separating capacitors. We need to consider the voltage levels on the base, collector and emitter of the transistors and these must blend in so that the two transistors are not fighting each other.

One of the simplest and best ways of doing this is to connect them as shown in figure 8. Q1 has automatic base-biasing via R1 and R2. This transistor settles down to a level of bias which is just at turn-on. In this condition its collector and emitter leads can be thought of as say a 4M7 resistor. This is due to the fact that it will be turned on only very slightly and pass a current of only a few micro-amps, just like a 4M7 resistor.

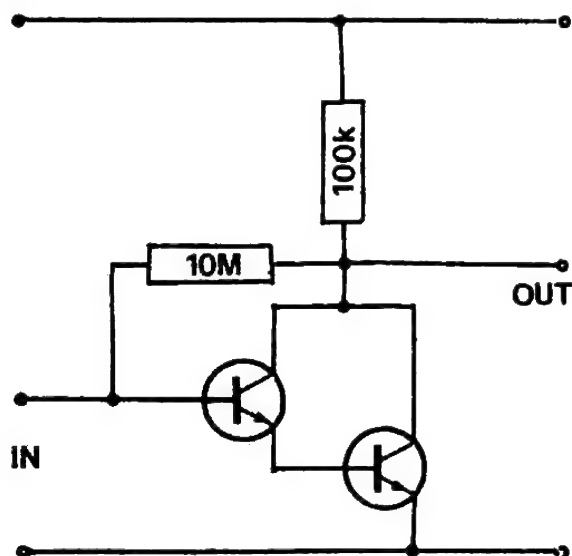


Fig. 8. SUPER ALPHA PAIR

Q2 will think it has a 4M7 resistor in the base-biasing line and will turn on very slightly too. The amount by which it turns on is very hard to describe. The easiest way to explain the final biasing conditions is to say that Q1 and Q2 turn on until an equilibrium is set up due to the voltage drop across the load resistor and the base voltage via the 10M resistor. If the transistor turns on harder, the collector voltage drops and the base voltage decreases.

Now the gain of this circuit is found by multiplying the gain of each transistor together. This can be in the region of 1,000 to 10,000 times and because of this high gain, the circuit is called a SUPER ALPHA PAIR. Another advantage of this circuit is the high impedance it presents at the input. It is ideal to be driven by crystal microphones or cartridges. And it can be coupled directly without the need for a capacitor. But the output will require a capacitor to separate this second stage from the next.

Another method of coupling two transistors directly is shown in figure 9. Q2 is connected as an emitter follower and this configuration is classified as a BUFFER. A buffer does not have to provide any amplification (i.e. voltage amp). But

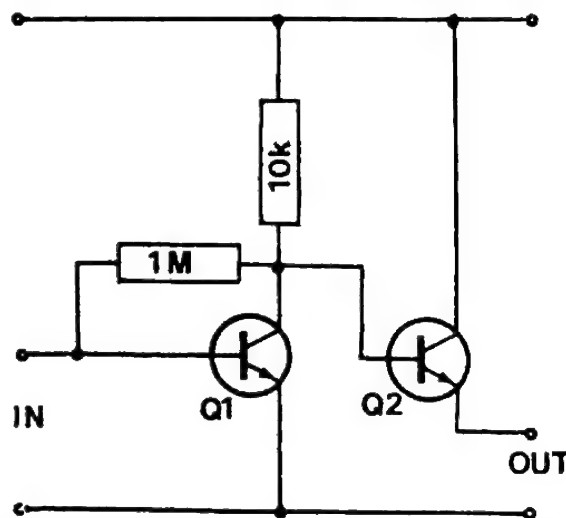


Fig. 9. EMITTER-FOLLOWER BUFFER

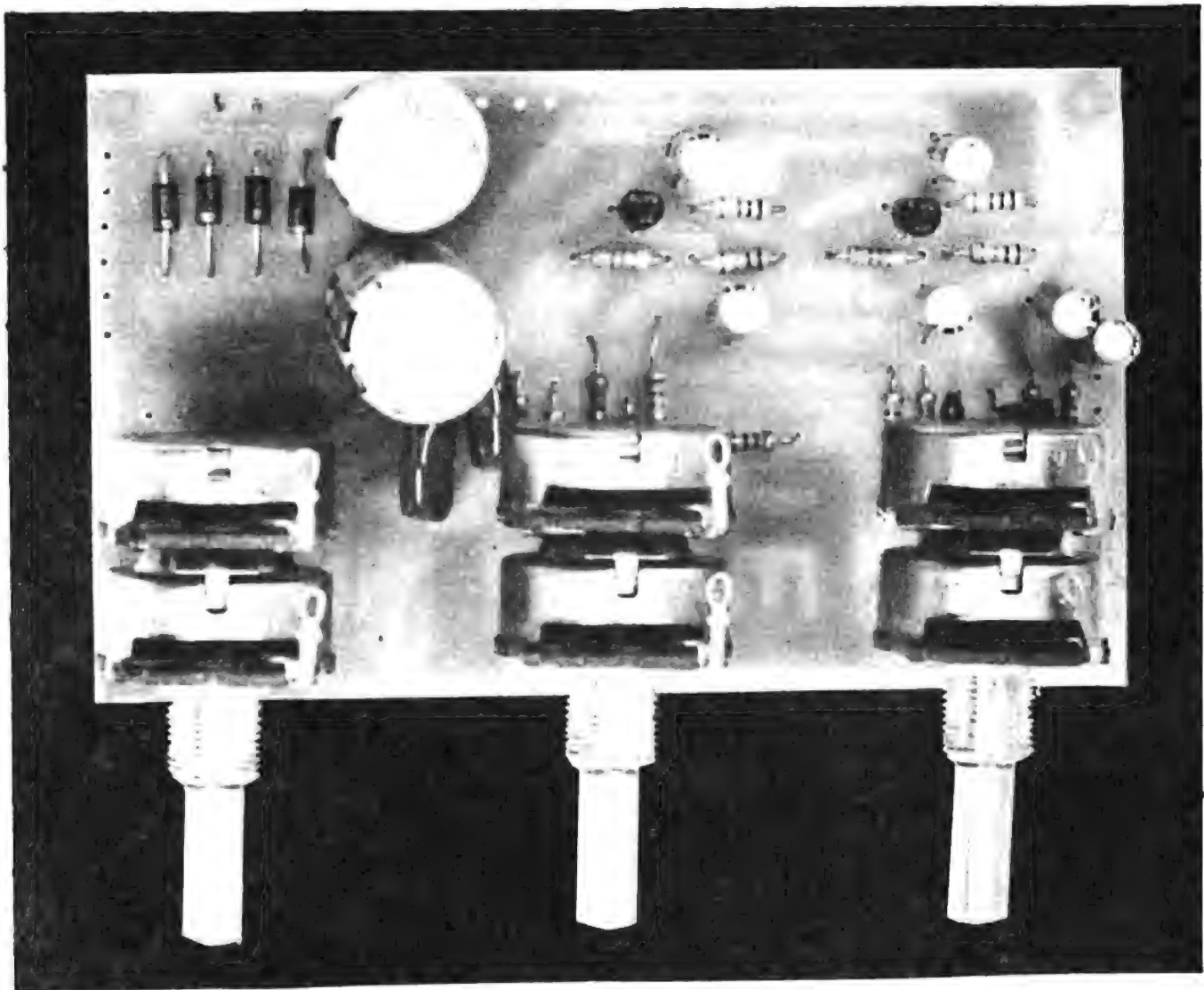
if it does, so well and good. Its main purpose is to provide high current sinking capability from a fairly feeble source. The mere fact that it does provide this function, is an indication that it is an amplifier. A current amplifier. But in this discussion we are concerned with power amplification when we speak of 'an amplifier'.

Although the emitter follower does not provide any voltage gain it does allow the first transistor to operate at maximum gain so that the overall gain of the circuit is considerable.

An emitter-follower can be likened to a fork-lift truck. The type having batteries to do the lifting. Suppose on the lifting platform we have a lever switch for the UP-DOWN motion. When you hold the switch in the up position, the motor lifts the load and the whole switch assembly rises too. Finally it gets out of arms reach. Pulling the switch down lowers the load. This is the same as an emitter follower. As you raise the base up and down, the emitter will follow with a voltage difference of only .6v. Very little current is required on the base line and considerably more current will be available at the emitter terminal. This current is supplied by the collector circuit. The emitter can never go higher than the base and it is tied to the base. - just like the switch on the fork-lift truck is always a constant distance from the lifting platform.

This concludes part 1. Next issue will deal with the transistor as a switch.

# STEREO SIMPLICITY AMPLIFIER

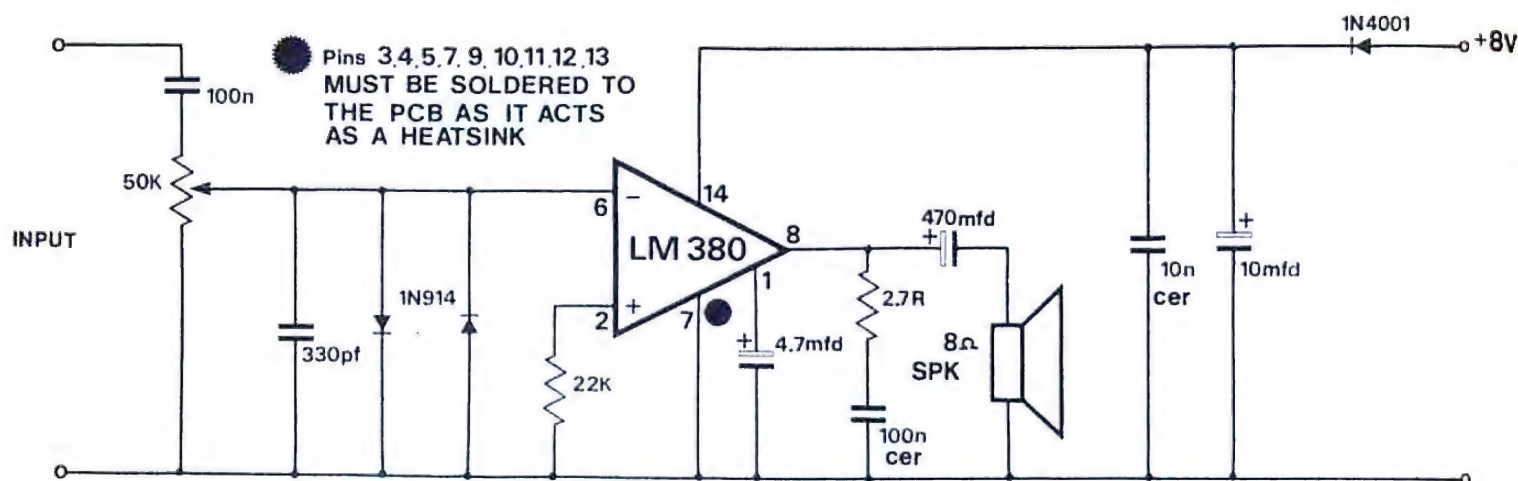


If you constructed our simplicity amplifier from issue 5 you will know easy Ron Mellor's design went together. The whole amplifier is contained within the LM 380 chip and heatsinking is provided by the layer of copper on the underside of the circuit board. Thus no awkward heatsink is required and the whole assemble is very compact. Now you can increase your pleasure. We have designed a stereo version of this amplifier and you only need to build one more amplifier module and combine it with the pre-amplifier, to complete a very inexpensive stereo system. If you have not yet ventured into

amplifier construction, now is the time. This is by far the simplest and cheapest stereo amplifier available and is so simple, it can be built by beginners.

Each amplifier is capable of delivering 4 watts into an 8 ohm speaker, making a total of 8 watts for the stereo version. This is adequate for a group of listeners and we had our unit operating from a 12v plug pack which delivered only about 200 to 300ma. The amplifier gave sufficient volume to herald a "turn that noise down" from any parent. So you don't need high wattage, just clean efficient amplifiers and good speakers.





## AMPLIFIER CIRCUIT FOR ONE CHANNEL

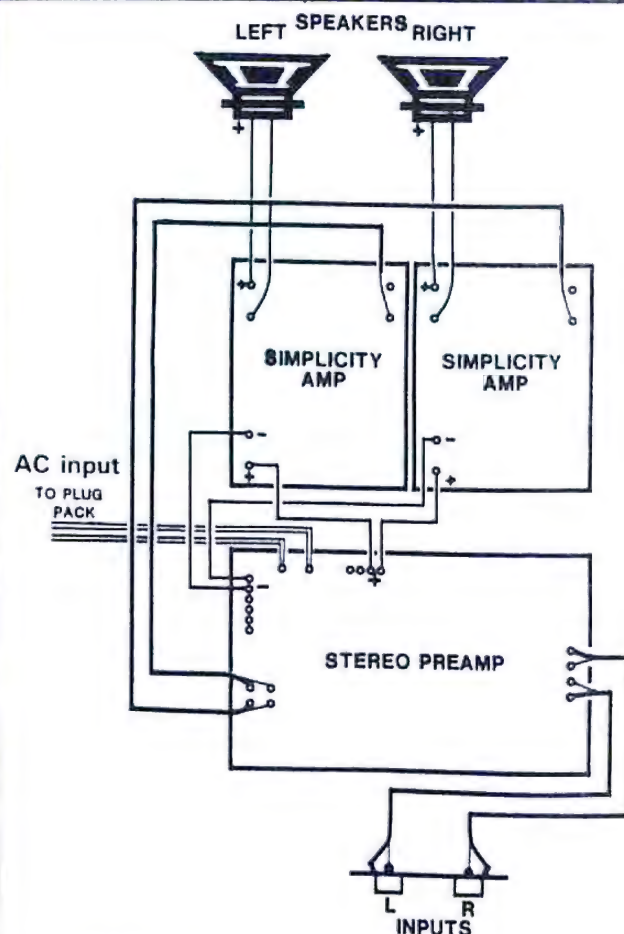
### HOW THE CIRCUIT WORKS

The STEREO SIMPLICITY amplifier can be connected directly to a stereo cartridge and each channel connected into the appropriate input. The signal from each channel will be modified by the base and treble controls which basically add capacitance to the circuit in parallel or series to give the tonal effects. The signal suffers some attenuation during this process and the BC 547 transistor is designed to restore the signal to its original amplitude. Each of the three controls are dual pots, with one section operating each channel. To conserve space we have shown only one channel. The other channel is identical and obviously the power supply is common to the three units.

From the output of the volume control it leaves the pre-amp board and passes to the two main amplifier boards. Here the signal passes through a 100nF capacitor which blocks any incoming DC from biasing the LM 380. The signal is then fed into a 50k pot which serves as a pre-set to set the maximum volume. The two input diodes prevent any voltage above 600 millivolts from entering the chip. The LM 380 requires only 150 millivolts for full output and could be damaged with higher spikes. The 22k resistor connects the non-inverting input to earth - approximating the input of the inverting input. Internal stabilization is provided by the 4.7mF electrolytic on pin 1.

Across the output we have added a 2.7 ohm in series with a 100nF capacitor to shunt any high frequency oscillation to deck. DC blocking to the speaker is provided by the 470mF electrolytic. It has a high value to pass the low frequency signals. This means that its impedance at even low frequencies will be low and most of the power will be passed to the speaker. The 10nF and 10mF capacitors provide power supply smoothing. It is always good design practice to have a number of smaller

electrolytics near each amplifying module. It provides added stability and reduces an annoying condition of feedback called 'motor-boating'. This is a putt-putt-putt-putt due to insufficient decoupling between amp and pre-amp stages. It will not occur in this design because the pre-amp stage provides very little gain.

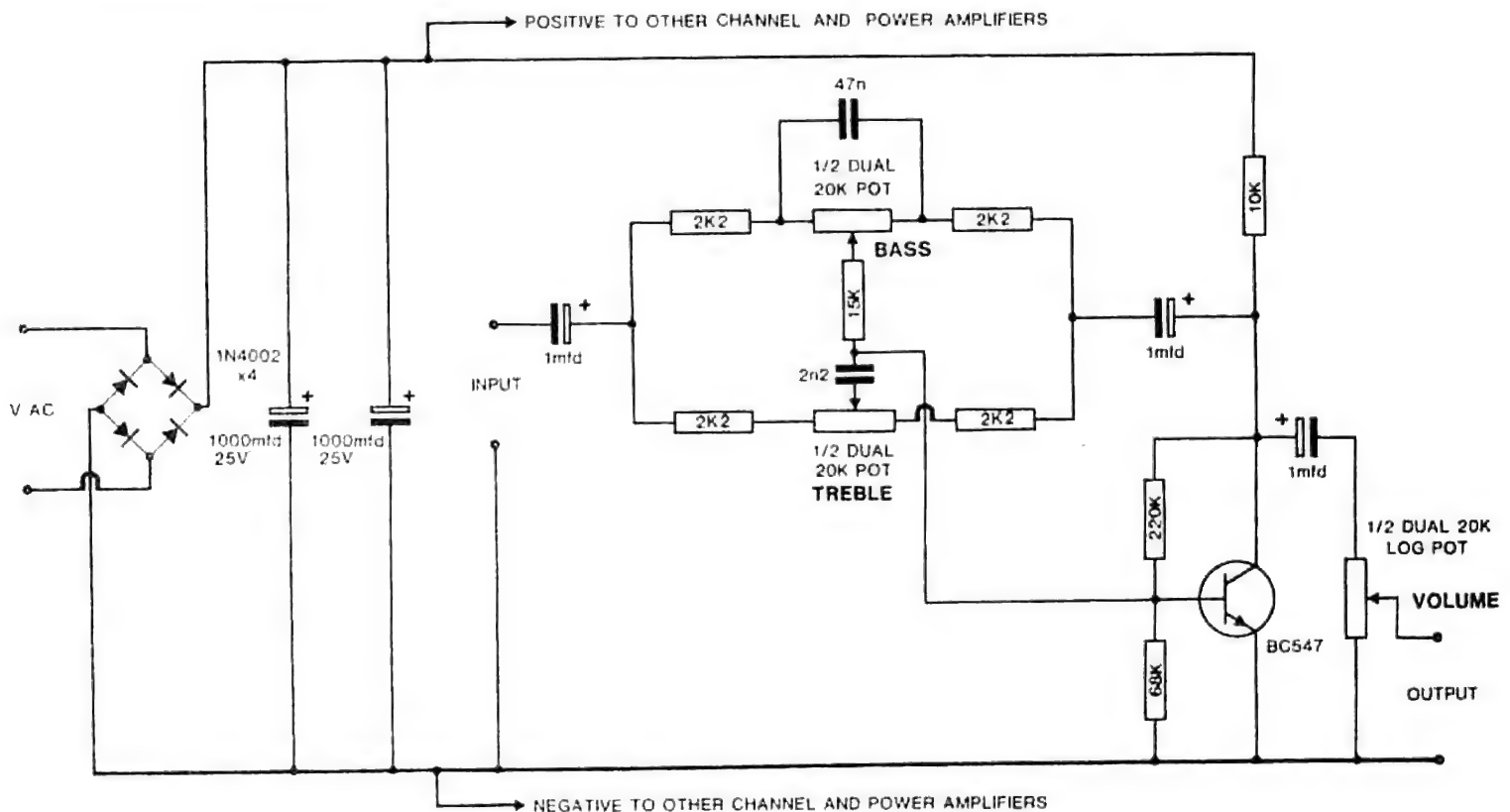
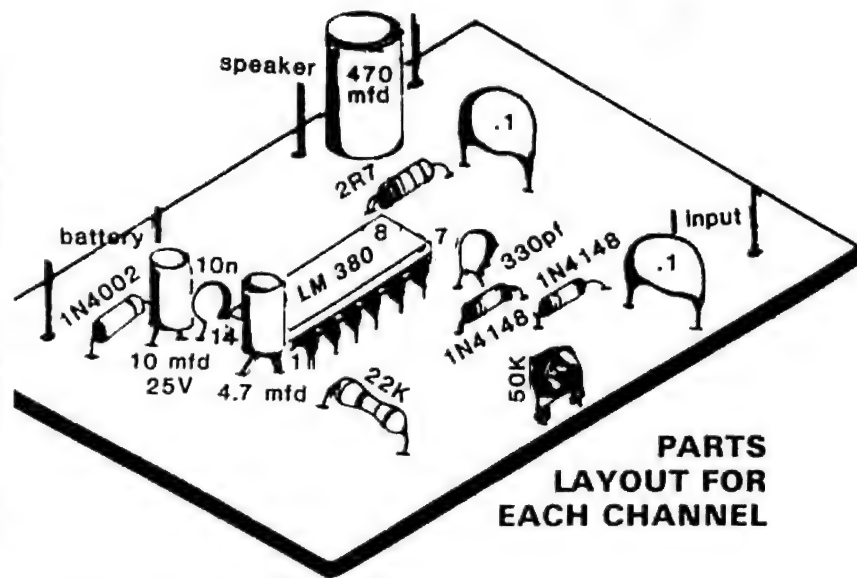


### WIRING THE MODULES

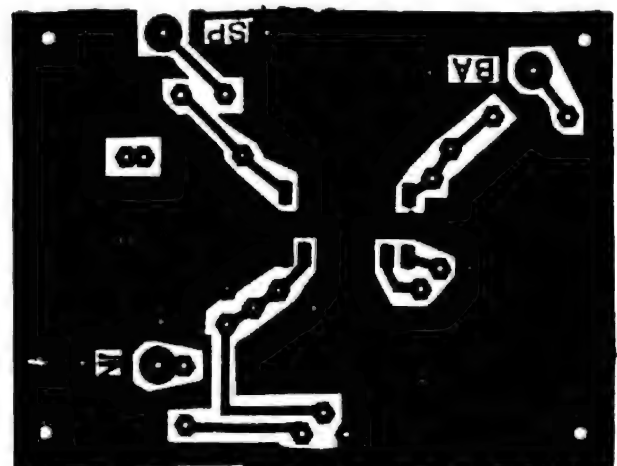
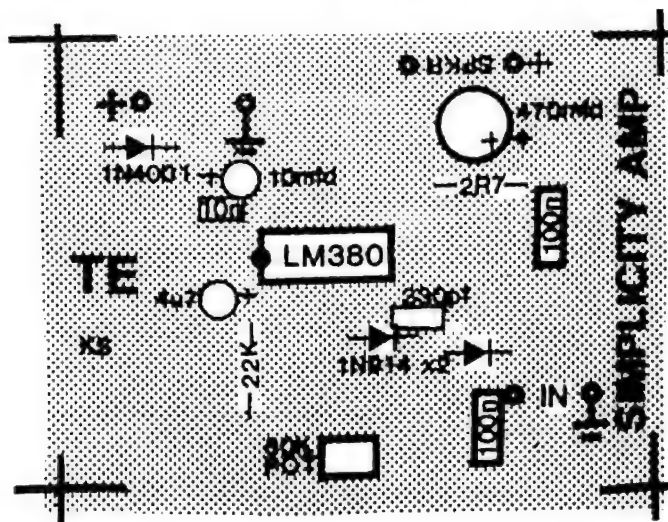


The stereo system is constructed on separate PC boards. The amplifiers are SIMPLICITY AMPLIFIER modules as described in issue 5 and these are connected to a pre-amp board containing a volume control, bass and treble controls and a simple power supply. The 3 modules are then housed in a cabinet of your own design.

The power rating for this project will depend on the mains transformer used. The most suitable type is 2155 which is rated at a maximum of 15v @ 1 amp. This type will produce the full rating of 8 watts RMS. With smaller transformers, the rating will reduce appreciably. However, using even the smallest plug pack will produce more than sufficient volume for comfortable listening.



## STEREO PRE-AMP CIRCUIT



## MOUNTING THE PARTS

The two amplifier boards are identical. You can refer to the notes in issue 5 for the layout and some further comments. For those who do not have issue 5, we have repeated the most relevant points again. All our PC boards now have an overlay to make assembly easy. The most difficult aspect to assembly will be in making a good solder joint. Since the majority of the underside of the board is tinned copper, it will heatsink the iron very quickly. This will result in a cold joint which will fail after a period of time. To produce a good set of connections, you will need a high wattage iron (at least 30 watt) and a fast reaction. Wait for the iron to heat up fully before attempting each joint and keep the soldering time short.

Begin with the resistors. Insert them fully so that they touch the board and splay the leads out slightly to keep them in position while soldering. The same applies to the capacitors, diodes and electrolytics.

The LM 380 must be soldered to the board and you cannot use an IC socket. This is because the board is acting as a heatsink for the chip. Make sure it is inserted around the correct way because you will have no chance of removing it once it is soldered. Each pin of the chip must be soldered, especially the centre pins as these will be conducting the heat from the body when the amplifier is in operation.

## ASSEMBLY

The best method of constructing this project is in three stages. Firstly build one amplifier and get it operating correctly. Next build the pre-amp section and connect the mono amplifier to it. This will provide the power necessary for the project and you will be able to test the volume and tone.

Finally construct the second SIMPLICITY AMPLIFIER and connect it to the pre-amp board.

WE have left cabinet construction up to you. Each module has a set of mounting holes and can be fitted to a set of standoffs. The most economical cabinet would be assembled by yourself and can quite simply be bent up out of sheet aluminium. A fancy wooden front can be mounted on the front and you can use a vinyl material to cover the wood. Use a set of rub-on decals to indicate the volume, treble and bass controls.

This amplifier should provide many hours of pleasurable listening, whether it be in your bedroom, lounge room or rumpus room.

## PARTS LIST FOR PRE-AMP

- 8 - 2k2
- 2 - 10k
- 2 - 15k
- 2 - 56k
- 2 - 220k
- 2 - BC 547 transistors
- 4 - IN 4002 diodes
- 2 - 2n2 greencap @ 100v
- 2 - 47n greencap @ 100v
- 6 - 1mfd electrolytic 16v PC
- 2 - 1000mfd electrolytic 16v PC
- 3 - 20k dual ganged pots
- 1 - STEREO PRE-AMP PC BOARD

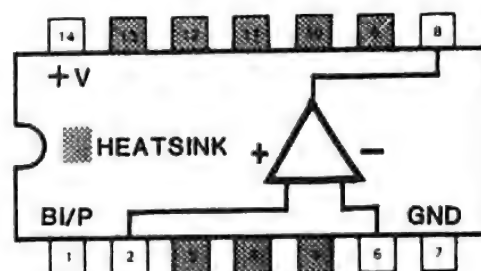
## PARTS LIST FOR EACH AMPLIFIER

- 1 - 2R7
- 1 - 22k
- 1 - 50k mini trim pot
- 1 - 330pf capacitor
- 1 - 10n greencap @ 100v
- 2 - 100n greencap @ 100v
- 1 - 4.7mfd electrolytic 16v PC
- 1 - 10mfd electrolytic 16v PC
- 1 - 470mfd electrolytic 16v PC
- 2 - 1N 4148 diode
- 1 - 1N4002
- 1 - LM 380 audio amp IC

## SIMPLICITY AMP PC Board.

Additional components:

- 1 - 100mm speaker 8 ohm
- 1 - length of single core shielded cable
- 1 - power transformer type 2155 or similar



LM 380 Pinout

## HOW A SERIES REGULATOR FILTERS RIPPLE

ANY RIPPLE APPEARING ON THE 20V LINE WILL EFFECTIVELY BE THE SAME AS RAISING THE INPUT VOLTAGE TO SAY 20.1V OR 20.4V. THIS INCREASED VOLTAGE IS NOT SENSED BY THE ZENER DIODE AS IT HAS A FIXED BREAKDOWN VOLTAGE OF 12V. SO THE ZENER BECOMES OUR BASE REFERENCE VOLTAGE. THE VOLTAGE INCREASE WILL BE SENSED BY Q2, THE ERROR SENSING TRANSISTOR.

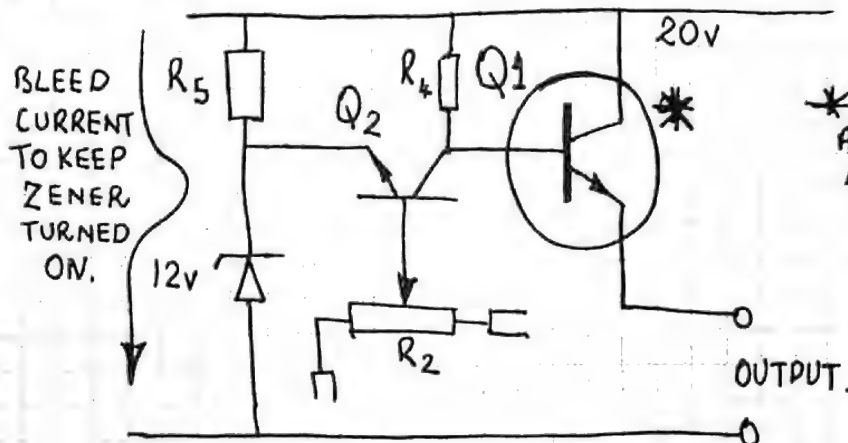
THIS IS HOW IT WORKS:

THE .1v OR .4v RIPPLE PASSES THROUGH Q1 AND APPEARS AT THE OUTPUT AS  $12.1v + .1v$  OR  $12.1v + .4v = 12.2v$  TO  $12.5v$ .

R2 IS THE "OUTPUT VOLTS" POTENTIOMETER AND WILL BE SET TO PARTIALLY TURN ON Q2, TO PROVIDE THE ORIGINAL EQUILIBRIUM OF 12.1V. THE .1v RIPPLE WILL TURN IT ON HARDER. THE VOLTAGE ON THE COLLECTOR WILL DECREASE & THIS WILL TURN Q2 VERY SLIGHTLY. THE EMITTER WILL FOLLOW THE BASE VOLTAGE BUT WILL BE ABOUT .6V LESS. THIS ACTION OCCURS VERY RAPIDLY AND CAN FOLLOW A RIPPLE OF FAIRLY HIGH FREQUENCY SO THAT IT IS PREVENTED FROM APPEARING IN THE OUTPUT. THUS THE CIRCUIT TAKES CORRECTIVE ACTION TO RESULT IN A MUCH SMOOTHER OUTPUT VOLTAGE.

SOMETHING LIKE A 2V P-P RIPPLE WILL BE CORRECTED TO 20mV AT FULL LOAD, USING THIS CIRCUIT.

IF YOU TURN THE WHOLE CIRCUIT AROUND  $90^\circ$  IT WILL APPEAR VERY SIMILAR TO AN EMITTER-FOLLOWER CONFIGURATION:

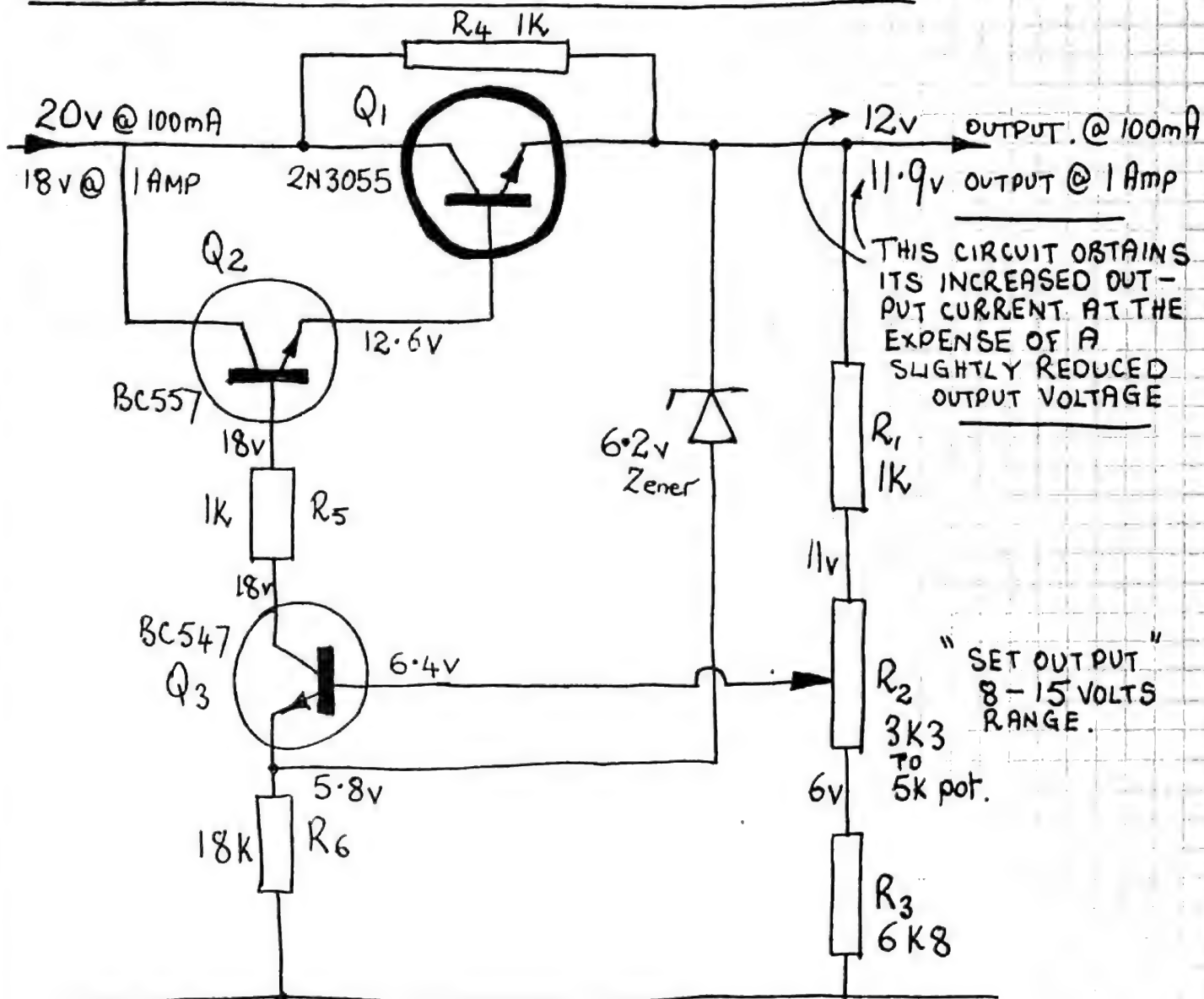


IN THIS LAYOUT ARRANGEMENT IT MAY BE A LITTLE CLEARER TO SEE HOW Q2 IS ACTING LIKE A VARIABLE RESISTOR BETWEEN COLLECTOR AND EMITTER LEADS TO PROVIDE A BASE VOLTAGE FOR Q1. WHEN Q2 ACTS LIKE A LOW VALUE RESISTOR, THE BASE OF Q1 THINKS IT IS CONNECTED TO THE CATHODE OF THE 12V ZENER. IT THEN PROVIDES AN OUTPUT VOLTAGE OF  $12v - .6v = 11.4v$ . WHEN Q2 IS A HIGH RESISTANCE THE BASE OF Q1 IS CONNECTED TO THE 20V RAIL AND THE OUTPUT IS 19.4V. IN ACTUAL OPERATION Q2 DOES NOT PROVIDE THIS WIDE A RANGE.

THIS CIRCUIT DOES SUFFER FROM ONE SLIGHT DISADVANTAGE. IT HAS NO OVER-LOAD PROTECTION OR SHORT-CIRCUIT PROTECTION. THE NEXT CIRCUIT ATTEMPTS TO FULFILL THESE CONDITIONS.



## SERIES REGULATOR WITH SHORT-CIRCUIT PROTECTION



THIS CIRCUIT PROVIDES SHORT-CIRCUIT PROTECTION. IF THE OUTPUT IS SHORTED TO GROUND THE REGULATOR WILL SHUT DOWN LEAVING R4 AS THE ONLY SOURCE OF SUPPLY. FOR THIS REASON R4 SHOULD BE A 5WATT WIRE-WOUND RESISTOR — EVEN THOUGH IT DOES NOT SUPPLY ANY CURRENT WHEN THE POWER SUPPLY IS OPERATING CORRECTLY. THE ONLY OTHER TIME R4 IS NEEDED IS FOR STARTING UP. IT MUST PROVIDE ABOUT 1V INTO THE OUTPUT TO START-UP THE CIRCUIT. THE "SET OUTPUT" POT DETECTS ABOUT 50% OF THE OUTPUT VOLTAGE TO BEGIN TO TURN ON Q3. THIS WILL TURN ON THE POWER DRIVER TRANSISTOR Q2, WHICH WILL TURN ON THE POWER REGULATOR TRANSISTOR Q1. THIS CONDITION WILL INCREASE AND STABILIZE WITH THE OUTPUT AT 12V. AND ABOUT 100mA LOAD CURRENT. WHEN THE LOAD IS INCREASED TO 1AMP, THE OUTPUT VOLTAGE REDUCES TO 11.9V WHICH EFFECTIVELY INCREASES THE BASE-EMITTER VOLTAGE OF Q1 TO .7V TO TURN IT ON HARDER. THE INPUT VOLTAGE MAY REDUCE BY 2V OR SO BUT THE BASE VOLTAGE OF Q1 WILL REMAIN STABLE AT 12.6V.

## OVERLOAD PROTECTION

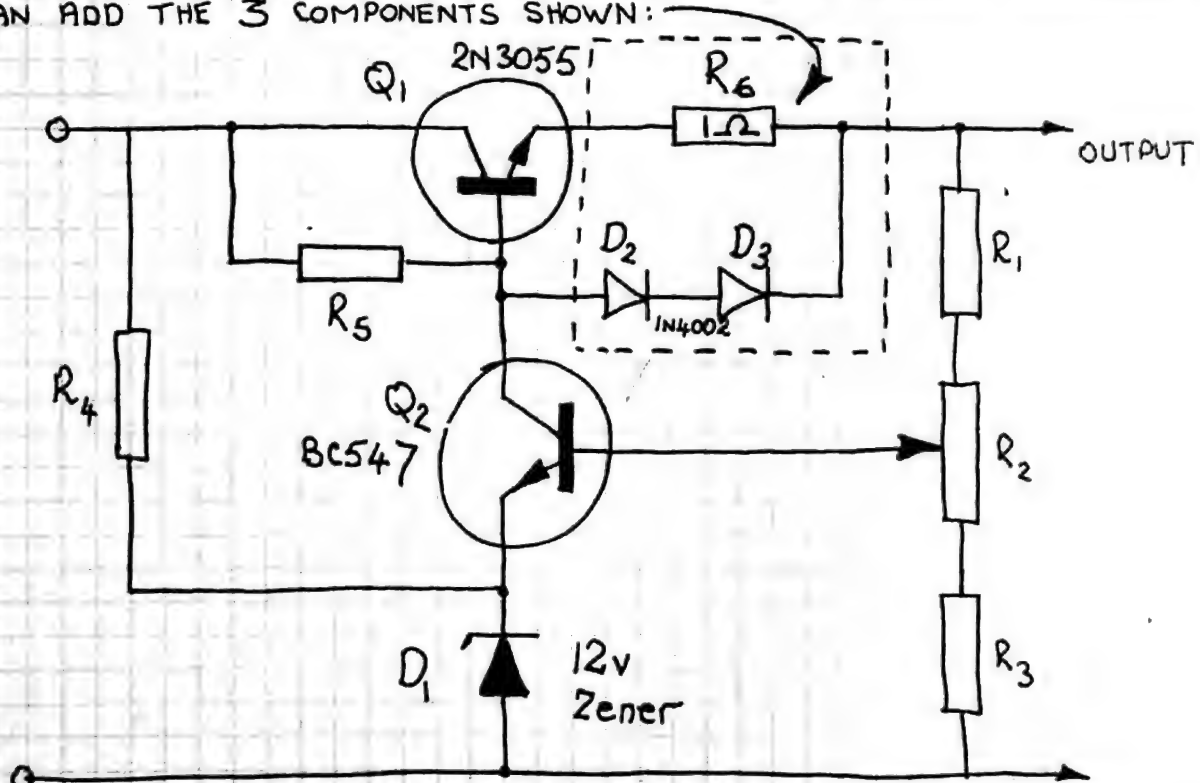
THE TWO PREVIOUS CIRCUITS PROVIDE 2 OUT OF 3 REQUIREMENTS FOR A GOOD POWER SUPPLY. THEY PROVIDE SMOOTHING & REGULATION (THE 2<sup>ND</sup> CIRCUIT ALSO HAS SHORT-CIRCUIT PROTECTION) THE 3<sup>RD</sup> IMPORTANT FEATURE TO BUILD INTO A POWER SUPPLY IS OVERLOAD PROTECTION. UP TO NOW THE ONLY FEATURE LIMITING THE MAXIMUM CURRENT IS THE CAPABILITY OF THE POWER TRANSFORMER AND THE CURRENT RATING OF THE POWER TRANSISTOR. A SHORT IN THE OUTPUT WILL ALLOW THE MAXIMUM TO BE UP TO 10 TIMES THE NORMAL CURRENT & THIS WILL CAUSE OVERHEATING AND POSSIBLE DAMAGE TO MANY OF THE COMPONENTS.

OVERLOAD PROTECTION SHOULD ALWAYS BE INCORPORATED INTO POWER SUPPLIES DELIVERING MORE THAN 1 AMP. NOT ONLY WILL IT SAVE YOUR POWER SUPPLY FROM DESTRUCTION BUT PREVENT POSSIBLE FIRE RISK AND REDUCE FURTHER DAMAGE TO THE EQUIPMENT BEING SUPPLIED.

PROTECTION COMES IN TWO DIFFERENT FORMS. THE SIMPLEST IS TO PROVIDE A CIRCUIT BREAKER OR FUSE IN THE OUTPUT. THIS WILL BLOW WHEN THE CURRENT RISES APPROX 30% OVER THE RECOMMENDED MAX. ONCE TRIPPED, THE CIRCUIT WILL NOT RESET ITSELF AND REQUIRES MANUAL RESETTING, OR REPLACING THE FUSE. THE OBVIOUS DISADVANTAGE WITH THIS IS THE INCONVENIENCE OF PHYSICALLY CHANGING THE FUSE. IN ADDITION TO THE SMALL COST OF A FUSE, THE EQUIPMENT IS OUT OF ACTION FOR AN INDETERMINATE (UNKNOWN LENGTH) PERIOD OF TIME.

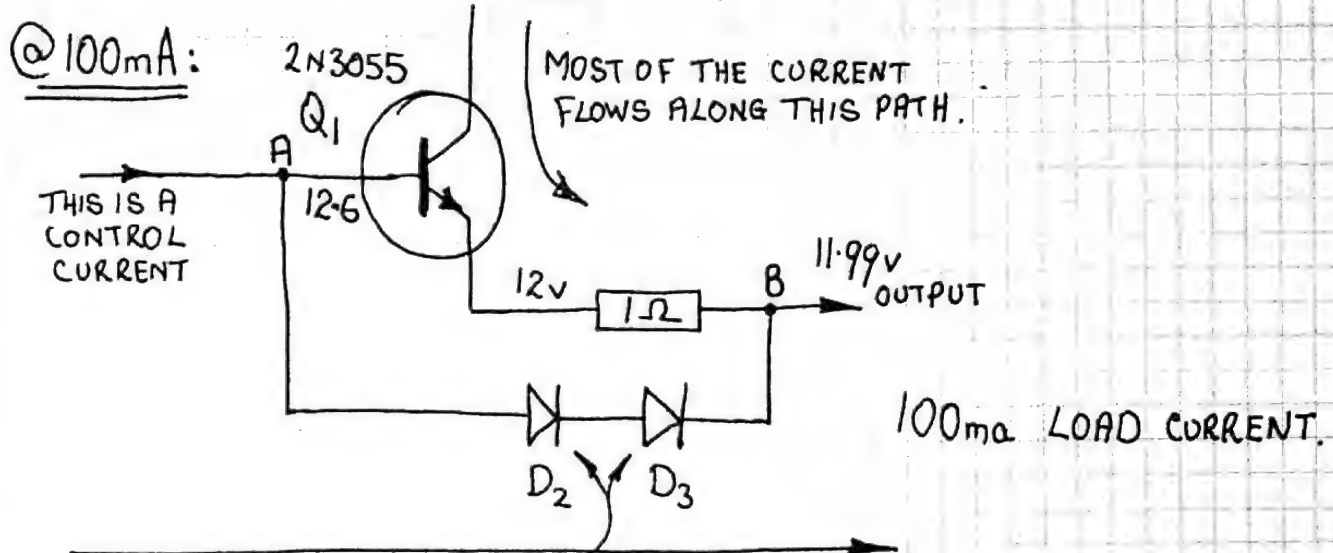
BEING ELECTRONICALLY MINDED, WE WOULDN'T TOLERATE THIS ARRANGEMENT FOR VERY LONG. SO AN ELECTRONIC OVERLOAD IS THE ANSWER.

TO PROTECT A SERIES REGULATOR FROM EXCESSIVE CURRENT OVERLOAD WE CAN ADD THE 3 COMPONENTS SHOWN:

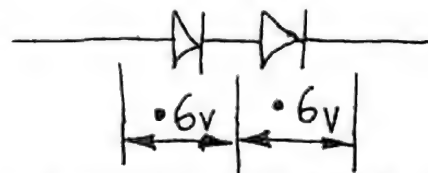


THE  $1\Omega$  RESISTOR IS IN SERIES WITH THE OUTPUT SO THAT ALL THE CURRENT FLOWS THROUGH IT. AS THE CURRENT INCREASES A VOLTAGE WILL BE DEVELOPED ACROSS THE RESISTOR ACCORDING TO OHMS LAW.

TURNING THE CIRCUIT AROUND  $90^\circ$  WILL MAKE THE OVERLOAD PROTECTION ARRANGEMENT EASIER TO FOLLOW:

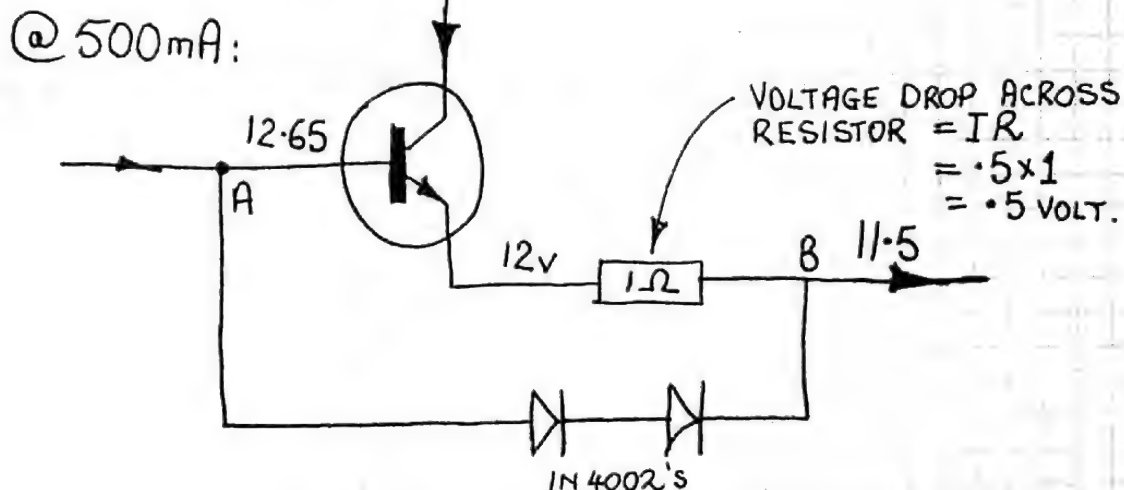


THE MOST IMPORTANT POINT TO KNOW IS A DIODE IN A FORWARD BIAS SITUATION WILL DROP A MAXIMUM OF .6V. THUS WITH THESE



TWO DIODES THE MAXIMUM VOLTAGE THEY WILL ALLOW TO BE DEVELOPED ACROSS THEM IS 1.2VOLTS. THIS MEANS THE MAXIMUM VOLTAGE BETWEEN POINTS A AND B WILL BE 1.2VOLTS. (AT THE MOMENT IT IS .61 VOLTS).

LET'S INCREASE THE CURRENT TO 500mA:





# THE WINNERS to: WIN A MULTIMETER!

We received about 55 entries to WIN A MULTIMETER CONTEST and this has encouraged us to produce another contest along slightly different lines in the near future.

As a side issue, the Technical Schools Electronics Section in Victoria is running a construction competition, through the Technical Schools, using a project from TALKING ELECTRONICS. A suitable project from one of the previous issues has been chosen and the broad terms of the contest will be to make your own printed circuit board using the photographic process to produce a neatly etched board, fully drilled. Another board will be required with all the components mounted on it. Neatness will be the main factor. Judges will be looking for small detail such as uniformity of resistor size, tolerance bands facing the same direction, resistors touching the board, transistors standing upright, LEDs displaying equal brightness, jumper wires with square bends but having no plier nicks, battery snaps soldered to the board without any stray wires, and ICs sitting close to the board. Neat soldering is

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**RIE ROD IRVING ELECTRONICS**

absolutely essential. Further details of this contest will be in the next issue of Talking Electronics and in the meantime you can contact the Technical Schools Electronics Section.

Back to our winners:

The three winning entries will receive \$25, \$15 and \$15. We needed to modify the second circuit to reduce the shut-down current, otherwise it may have come first.

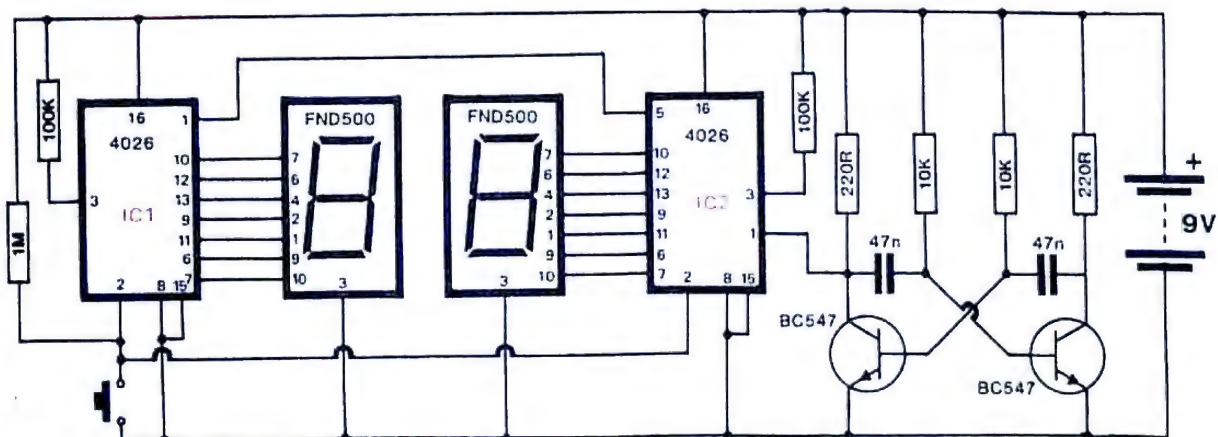
So far we have presented 8 circuits from readers and if you have a circuit suitable for publication, send it in.

Congratulations to the winners and a big thanks to all the others who wrote in.

Here are the winning entries:

## 1st Prize:

P Barrett  
Edwards Road  
Wahroonga 2076



## PERCENTILE DICE

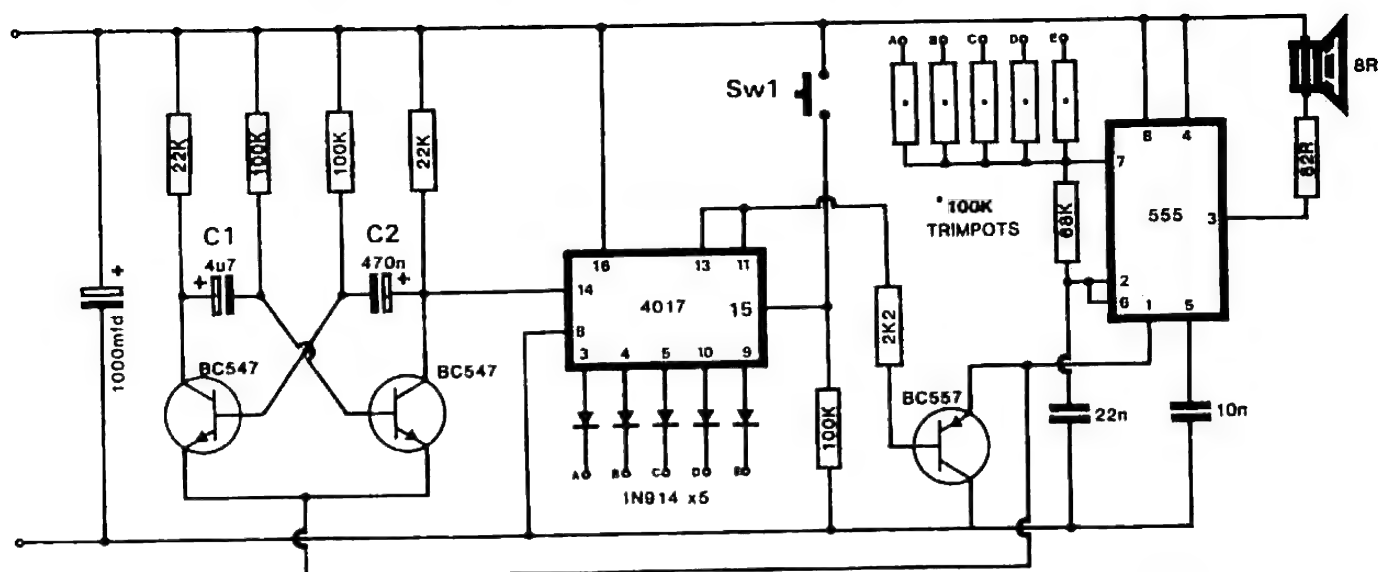
Percentile dice are very common in war games. Unfortunately electronic percentile dice are very hard to come by. So here it is: Q1 and Q2 form a square wave oscillator producing a 1kHz frequency at pin 1 of IC2. This IC decodes the input pulse to give a readout on the 'units' display. The CD 4026 has a 'c out' at pin 5 which is a decade division of the input frequency. This drives the 'tens' display to give a reading from 00 to 99. If the

oscillator was slowed down sufficiently to see the count taking place, you would detect a complete count to 99 before commencing at 00. When the push button is pressed, the display blanks and the count takes place. When the button is released, a random percentage is displayed.

I found this project to hold much more interest than the normal decade dice as used in strategy games.

## 2nd Prize: DOOR CHIME

R N Sinclair  
Brooke Street  
COOGEE, 2034



The circuit consists of 4 building blocks: MULTIVIBRATOR, COUNTER, SHUT-DOWN SWITCH and TONE OSCILLATOR.

The first block consisting of the multivibrator is built around Q1 and Q2 and its frequency is set by C1 and C2. The multivibrator is the clock in this circuit and determines the rate at which the tones are switched into circuit. The choice of C1 and C2, being a 10:1 ratio, gives a rapid clock rate with a long 'on' time for the tone.

The clock pulses are fed directly into the CD 4017 counter IC. This counter is a decade counter and has 10 available outputs. In this circuit I have wired the 10th output directly to the clock inhibit pin, so

that when this output goes HIGH, the 4017 will not advance any further.

To commence counting, Sw1 is inserted in the reset line. Outputs 0-8 can all be used to give 9 tones but the proto-type uses only 0,2,4, and 8. This gives a space between each tone.

Diodes D1 to D5 give isolation between each output and as they go HIGH, the respective resistor (R6 - R10) is enabled in the tone oscillator circuit to give the desired sound.

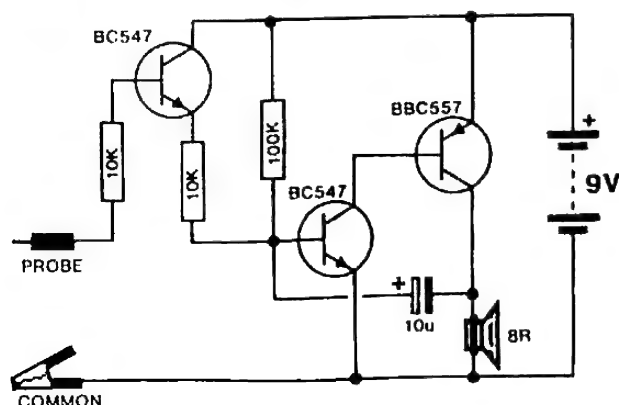
Once the 4017 has counted to output '9', pin 11 goes HIGH and turns off Q3. This transistor switches off the 555 IC and the transistor multivibrator. Power is always applied to the circuit but

only IC1 is energised. The quiescent current is only about 20 microamps and has no effect on the life of the battery. When Sw1 is pressed, the decade counter is reset. This turns the transistor on, supplies current to the multivibrator and tone oscillator.

The circuit can be altered and extended to give additional tones and the speed of selection can be decreased by adjusting the multivibrator. An easy method of setting up the circuit is to use a slow clock rate and substitute R6 to R10 with 100k pre-sets. When a final set of pleasing notes is obtained, the pre-sets can be replaced with fixed resistors. This circuit was built on a printed circuit board to give a neat appearance. I have used it for some months in our home as the front door bell.

## 3rd Prize: AUDIO LOGIC PROBE

Grant McLean  
12 Arawa Street  
GORE NZ



A LOGIC PROBE can be of more use than a multi-meter when trouble-shooting a digital project. There are many circuit around for logic probes using LEDs to indicate the logic state. These have the disadvantage of requiring the user to possess three pairs of eyes. One to watch the probe point. One to see what the circuit is doing, and one to watch the LEDs on the probe.

This circuit solves that problem.

It comprises a simple 2 transistor multivibrator and a transistor switch to change the frequency. No component values are critical and the circuit can easily be assembled on a small piece of Veroboard.

**TO USE:** Clip the alligator clip to the negative rail of the circuit under test. The frequency emitted from the speaker indicates the logic level:  
HIGH FREQUENCY = LOGIC HIGH  
LOW FREQUENCY = LOGIC LOW



We review the...

# LOGIC DESIGNER

The second project book in the series has just been released. Here is a synopsis of what it is and what it does.

See **PROJECT BOOK No 2. on P. 41.**  
**Book and PC board \$3.95.**  
**Kit of components \$15.25.**

Do you want to build a project quickly at the least expense?

The answer is obviously YES!

So, the solution is to bread-board it.

Bread-boarding saves time and money. All the parts are fully recoverable and it only takes a moment to pull apart a whole night's work. But what if you want to retain it? You can't keep it indefinitely on the bread-board. So how do you get it from the bread-board into a final design, with the least effort?

Up to now, getting from a bread-board layout to a PC board has required time, effort and skill. And it is during this operation that a mistake could creep in. You may lay the PC tracks incorrectly or leave out a jumper line or one of a thousand faults. In fact it proved to be the most difficult stage of design. And produced the most worry.

This has now been solved. We have designed a printed circuit board which is an exact copy of the under-side wiring of the bread-board. This means you can transfer the components from the bread-board and place them on the PC board without having to re-design anything. If the proto-type worked on the bread-board, the printed circuit will work also.

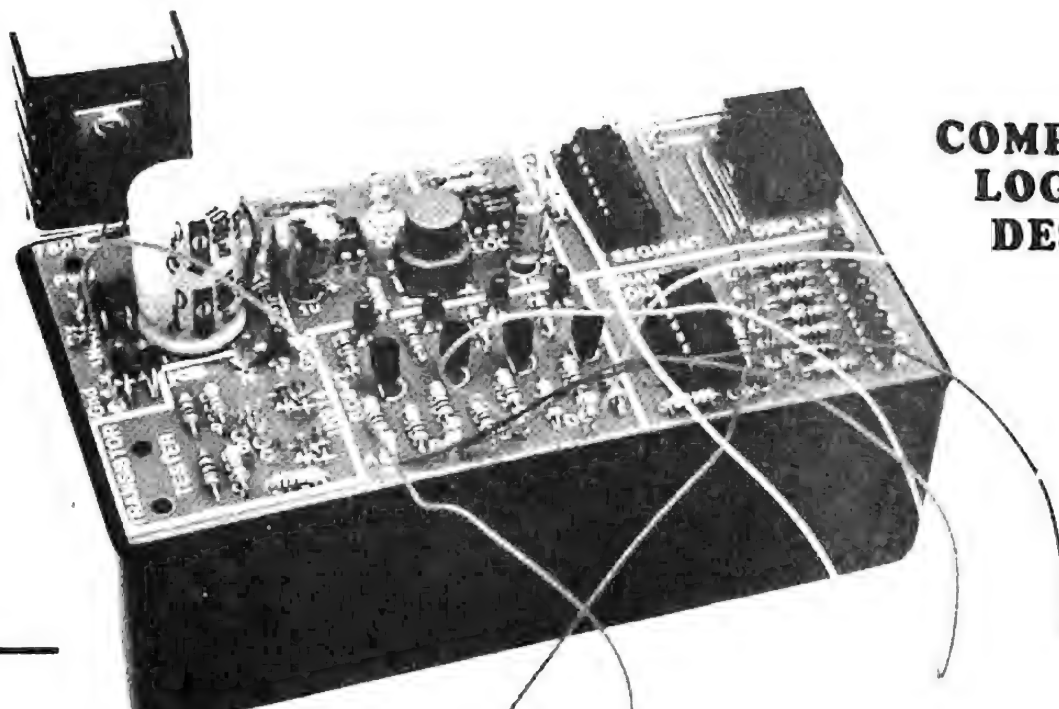
Just before you transfer the parts, it is wise to make a sketch of the layout, just in case something gets misplaced.

This revolutionary approach is the basis to our second project book.

The ELLISTRONICS bread-board started the whole thing off and after its run-away success, we decided to provide a back-up for the countless hobbyists who would be requiring the next stage in design aids.

Contained in the last part of the LOGIC DESIGNER book is a set of grids on which you can draw the layout of the parts in readiness for PC construction. If you don't want to build the unit immediately, the sketch can be kept as a reference. At least you have completed the most important stage and proven the circuit works correctly.

But that's only a small part of the LOGIC DESIGNER book. The first section describes and entirely new project. It is a logic designer. And that's exactly what it does. It helps you design logic circuits by providing a number of building blocks to either complement a design or test it.



**COMPLETED  
LOGIC  
DESIGNER**



Accompanying the book is a Printed Circuit Board on which you can build the LOGIC DESIGNER. You can see the finished project in the accompanying photos and basically it consists of 7 separate sections:

- A 1 amp power supply with full voltage regulation.
- A one-shot circuit using a 555 to de-bounce a push-switch.
- A 10Hz clock.
- A 7-segment display driven by a CD 4026 IC.
- A binary counter capable of counting to 128.
- Four buffer transistors with LED read out.
- A simple transistor tester.

All this is contained on a board the same size as the top of a Jiffy box so that you can mount the project on this type of box in place of the aluminium lid. When complete it looks just like the photo.

The best part of the LOGIC DESIGNER is its dual capability. It can be used by itself to produce a number of interesting counting sequences or it can be combined with breadboard to construct more complex circuits. It can even be used to help diagnose faults in any of the projects from Talking Electronics.

In fact it is a miniature version of the \$100 logic designers currently available. And when you compare the prices, you'll agree without hesitation. Ours is the best value for money.

After you build the LOGIC DESIGNER, you will want to do some experimenting. The centre pages of the book contain 13 experiments using only the logic designer itself. They cover only a fraction of the possible combinations as the 7 building blocks can be interconnected in so many ways. The experiments start with the simple connections and advance to more complex arrangements. But after a while you need extra components for gating and this will involve some form of breadboarding system. But at least 12 of the experiments can be built on the breadboard itself by using jumper leads to connect the blocks together.

The only under-designed component on the board are the Molex pins. All we could buy in the form of a cheap termination for the jumper leads were these flimsy pins. They don't really last very long in this situation but I am sure you will find an improvement. Possibly a set of leads with clips would be more robust and you could use either wire or matrix pins for the test points.

The LOGIC DESIGNER will operate from batteries or a Plug Pack of the AC type. This will save wiring up any mains transformers and will

make the project acceptable by schools as no 240v is allowed in these groups

The output capability of the power supply is almost entirely limited to the rating of the power transformer. The LOGIC DESIGNER itself requires less than one hundred milliamps. The balance of the supply is available for other circuits.



*Andre Switzer, at Sandingham Technical School, making final wiring with jumpers before connecting the DESIGNER to an AC plug Pack.*

Three voltage ranges are provided: 5v 9v and 12v. This should cover most applications. The one-shot circuit uses a 555 to de-bounce an ordinary push-button. I noticed that the 1 mfd electrolytic has been identified on the overlay around the wrong way. When I tried to increase the time delay by using a 10 mfd electrolytic, it had no effect. When I reversed the electrolytic as per the circuit diagram, it operated perfectly. Although the one-shot circuit works without and problem using the 1mfd capacitor, it can be increased up to 10 mfd to make sure the delay has not elapsed before the button is released. By increasing the delay, you would be limiting the maximum clock rate to about 1 pulse per second. This may be fairly annoying if you need to pulse a circuit a number of times.

The 10Hz clock will take the effort out of clocking a counter such as the CD 4024. This counter really helps you learn the binary code and you can follow the LEDs as they turn on and off in sequence.

The 7-segment display uses a CD 4026 to drive an FND 500. This will give a 0-9 readout from a single clock line. Very handy for counting. This block can be cascaded to create a counter which will count into the 1,000's if you buy more LOGIC DESIGNER PCB's.

The binary counter has its uses too. Each output is a divide-by-two and thus a signal can be halved, quartered etc. This will give rather odd divisions and to get decade divisions, the counter must be decoded. Experiment 10 shows what we mean by decoding.

The four buffer transistors will detect a signal as low as .65v and can be used individually to obtain 4 readouts at the same time. Normally you would require 4 multimeters to do the same job.

Finally the transistor tester. It is only a simple tester but with a very clever addition. Four diodes have been placed in series with the collector lead to prevent a shorted junction acting like a diode and giving a readout similar to a good transistor. The transistor tester requires the AC input and if you use a DC power pack, you will lose the transistor tester section.

That's it. I am sure you agree its good value for money and and the maximum use of the board. After you build it, and carry out the experiments, you will want to see how it helps you fix other projects.

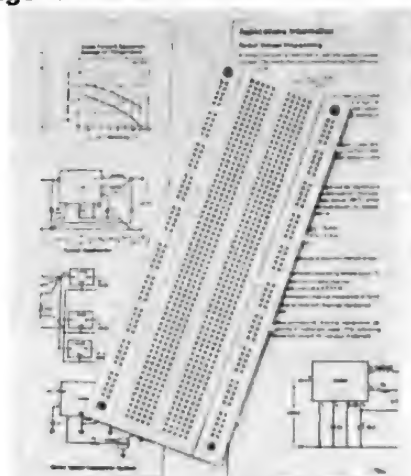
The first thing you will need to do is connect a battery snap so that it will drive other projects. This snap must be wired in reverse. The negative lead must be connected to the positive rail on the board and the positive lead connected to the earth point as marked on the board with the letters "gnd". This will allow you clip the two snaps together.

One of the best projects to try with the LOGIC DESIGNER is the HANGMAN. It uses a lot of on-off logic, a high frequency oscillator a small amount of analogue voltage and a voltage doubler.

Firstly start by measuring the voltage out of the doubler circuit with a LED connected to a 2k2 resistor. When you compare the brightness of the boost line with the 9v coming into the project, you will see that the boost is operating. If there is no difference, you should measure the frequency coming out of the oscillator circuit. Touch either of the 4k7 resistors with a lead connected to the clock input of the 4024 binary counter. The 7th LED of the binary counter will flicker on and off very quickly. This readout can be slowed down to one-tenth the speed by connecting the 7-segment display between the oscillator and the binary counter to give a decade division. To achieve this, connect the clock of the 4026 to the oscillator and the 'C out' to the clock input of the 4024. This will give a divide by 1280 which in very round terms is divide-by-1,000.

In our project, we counted the number of flashes of LED 7 and worked out the frequency of the oscillator to be about 2KHz. Once the boost is operating, the next section to test is the turn-on of the staircase. Take a 1k resistor from the boost rail and touch it on the row of

base resistors. All of the LEDs should come on and LED 8 should flash. Once this is confirmed, use the turn-on resistor on the base lead of Q1. Again, the transistors should light up. If not, remove the shut-down transistor. It may have shorted or become slightly turned-on due to leakage in the shut-down wires.



*This is the bread-board that started it all. The LOGIC DESIGNER book contains 27 blank grids the exact same size as the bread-board for sketching your layouts.*

The final sections to test are the two one-shot circuits. These comprise gates 'a' and 'b', 'c' and 'd'. Use one of the buffer transistors to detect a LOW on pin 3 of IC 1 and when you place your finger on the TOUCH SWITCH, the output changes to a HIGH for the whole time your finger is applied.

Remove your finger and test the output of pin 4. It will be sitting with a HIGH on it. When you touch the touch switch, this HIGH changes to a LOW for 1/2 second, then goes HIGH. You have to remove your finger and re-apply it to change the state of the circuit. Next detect the brief pulse on pin 10. This HIGH appears only after you have touched the touch switch and occurs only once for each application.

Any other faults will possibly involve damaged components such as over-heating the IC's or the transistors. Also check for bad solder connections such as dry joints or dags of solder bridging two lands.

Other problems would be of an individual nature and need special testing.

You can use the same reasoning to work your way through many of the other project we have presented in TE. In a future edition, we will help you with diagnosing another project using the LOGIC DESIGNER.

For the moment, you should try and secure yourself a copy of the book. If your newsagent has sold out, you can send directly to TE. And maybe buy the complete set of 5 issues as you will then receive them immediately they are printed.

# SHOP TALK

In the near future we will be looking into the most important topics which should be included in an electronics syllabus. At the moment we have received only one or two syllabii from High and Technical Schools. It seems a lot more emphasis needs to be placed on the digital aspect of electronics and so far these topics are only just creeping into the course at some terminal portion of the course. It will be our intention to formulate a set of topics for a three year course which would become universal throughout Australia. After all, electronic components are universal and the same equipment is sold throughout Australia, so I consider the courses should be identical in all Teaching Centres.

My main aim will be for an improvement to the digital aspect of electronics. If you have any relevant information on course content or suggestions for content, please send them to me at TE.

Younger readers, interested in pursuing electronics as a career will be interested in the following syllabus we have just received. It will let you know the type of subjects to be covered and the content of the course. Later on, we will have a breakdown of each topic so you can prepare yourself for the type of sections to be covered.

Each of these topics is a 3 hour lesson. They pre-suppose no prior knowledge of electronics and only the minimum of mathematics will be encountered.

Introduction and Electronic Systems  
Electrical Quantities - voltage, current and resistance  
Instrument 1: signal generators and multimeter  
Instruments 2: miscellaneous instruments, oscilloscope  
Transducers - Piezo effect, magnetic induction  
Transducers - various kinds  
Batteries - primary and secondary cell care  
Power Supplies - transformers  
Power Supplies - diodes and rectifiers  
Power Supplies - filters  
Power Supplies - zener diodes, fuses  
Amplifiers - characteristics and types  
Operational Amplifiers - inverting  
Operational Amplifiers - non-inverting and testing  
Bipolar Junction Transistor - current gain  
Field Effect Transistor - JFET and MOSFET  
Ohms Law - series and parallel resistance  
Power and Voltage Divider  
Capacitance  
Amplifier Circuit - common emitter source  
Amplifiers - process of amplification  
Amplifiers - commercial circuit review  
Special Semiconductors - UJT  
Special Semiconductors - thyristor family  
Timers - 555 family  
Oscillators - LC type  
Opto Electronics  
Power Amplifiers - push-pull types  
Regulated Power Supplies  
Digital Electronics - flip-flops, half adder  
Digital Electronics - circuit examples

## NOT SO, SWIFT!

You may see the funny side to this:

In issue 6 you may recall we had a light alarm project returned by Mr G Swift of Glenbrook with the comment that it was killing his batteries. We modified his project and used the beeper circuit on P 44 of issue 6. All the components were re-fitted back into his box and the PE cell placed up against the window in the box to detect ambient light. We included a rather flat battery and placed the whole project in a Jiffy bag. We could hear a slight tick from inside the bag so decided to put 2 layers of black paper over the window to shut it up. That worked fine. No noise emanated from the speaker so we folded, stapled and taped the Jiffy bag and placed it in our posting-box. It was not until later in the afternoon that we went to the post office. As soon as we went out into the bright sunlight we heard a slight ticking sound! From deep inside the masses of parcels came a tick, tick, click, click. The sunlight had penetrated the Jiffy bag and black paper mask to start the beeps. Rather than pull the packet apart we decided to write on the envelope "ALARM ENCLOSED". "KEEP OUT OF SUNLIGHT".

To date, we have not heard from Mr Swift as to whether he received the parcel and if it had been opened by the Postal Department or whether the battery was too flat to operate the alarm.

## NO PCs?

I'm not going to make a feature out of this, but we will be providing issues of TALKING ELECTRONICS without PC boards on a subscription basis.

Normally, anyone renewing their subscription will receive 4 issues for \$14.00. It will only be under special circumstances or by request, that we will supply TE without PCs. Due to the increased postage rates and printing costs, TE magazine will rise to \$1.50 per copy without the PC board. Plus \$1.00 postage. A TE subscription without boards will cost \$18.00 for 12 issues. So far we have had less than 3% of readers requiring "no boards" and it is intended only as a service. It goes against the grain to regress. I know it has been difficult for some younger readers to find the money for the magazine while others can earn a little doing odd jobs. So this arrangement may be acceptable.

If you require NO BOARDS, you must make a specific request.



# WHAT! . . . \$3.75!!

What! . . . \$3.75!! I wonder if this is what you thought when you first saw issue 6 of TE? I know some people did. They told me so. Instead of the miniscule \$1.20, TE had jumped to \$3.75! A 300% increase!! In fact it could be thought TE was trying to put itself out of business. And that's what some people believed.

The introduction of the PC board was a calculated venture, and one which is well-worth relating.

The reaction from readers has been varied to say the least and since we are all in this together, I think you will be interested to hear the comments I have received, both directly and indirectly. You may even be responsible for one of over 200 comments and replies I have collected in the first two weeks of the magazine's release in the bookshops.

If so, you will know how much I appreciate these comments, whether they be praise or criticism. I have collected together a sample of these views and if the results could be extrapolated over the whole readership, you would be pleasantly surprised at the findings.

The idea of including a PC board with a magazine was envisaged as far back as 15 years. It has long been my desire to mass produce a printed circuit board to back-up the main project in a magazine.

Theoretically, this has far reaching consequences. Consider the instant benefits of supplying a large group with a decoder board for satellite transmission or bar-code deciphering, so that you could read the printed codes on grocery items. Or we could print a complete page in code for instant loading into your computer. I could even go further and maybe invent a simple reading machine for partially sighted persons or blind people or design a sensor-monitor to protect 2 month-old babies from the dreaded cot death syndrome. Or maybe design a sensor to monitor a diabetics blood-sugar level. The advantage of the board with a magazine lies in the forced encouragement it presents.

So, why not start now with the concept?

Fifteen years went by before the time, place and finance present the right combination for such an idea. It firstly started with the introduction of TALKING ELECTRONICS. As the success and feed-back from the magazine showed it to be a valuable addition and well constructed in concept, we moved on to the more enterprising aspect: To produce a PC board. We started in a small way with a set of project books which were designed around an individual piece of test equipment. The first book was to be a MINI FREQUENCY COUNTER. From the response to this booklet, we would decide the acceptance or otherwise, of this idea. To our great surprise, it was more success than we thought. From the outset, we had been monitoring 6 outlets in Victoria and a number interstate by reliable helpers.

Within 2 weeks of the Mini Frequency Counter being released, it had sold out. Could we go by these sales figures for TE? The Mini Frequency Counter was a test gear project and would the sales relate to TE, with its general range of projects?

Maybe yes, Maybe no. It wasn't until we were half way through compiling issue 6 that we decided to go for a PC board on the cover.

I knew it would cause quite a deal of consternation. All the readers would be expecting to see TE on the shelf for \$1.20. What would they think at \$3.75? After a lot more internal discussion, and arranging, it was decided to go all the way.

We would live or die by that decision.

We knew that not only would the board increase the price of the magazine, but it would also delay its appearance by two weeks. This being the time needed to hand staple the 20,000 boards to the issues.

Well, this is all history now. The idea has been done and the magazine has finally appeared. All we needed to do was sit back and see the results.

Within three days it happened. It was just as we thought. The flack came first. Those who did not like the idea were the first to let us know. In fact, even up to now, the longest letters came from those unhappy with the concept.

For varying reasons they didn't think printed circuit boards should be included. Out of the first 100 letters and orders, we received 8 who didn't like the PC board. In all fairness, I might add that one letter was from a brazing firm, another sold vending machines, another operated as a community library while 5 readers produced their own PC boards and would prefer to continue to do so.

In the back of our minds, we had prepared a possible alternative for these people and it was not until we got a PC board returned personally by a very indignant reader, that we decided on a positive alternative. He had travelled some 60km, with the board, to come and demand a re-allocation of two issues in place of the board.

This speeded our decision to produce two types of subscription. One for readers wishing to receive the PCB's and the other for readers wanting the magazine only.

Unfortunately it would not be possible to distribute two releases through the shops, one having a PC board attached, the other having no PC board. The accounting difficulties would cause chaos.

The only way to overcome this would be to have two subscriptions. So this is what we have done.

A 4 issue subscription with the Printed Circuit Boards will cost \$14.00 posted to any state of Australia. A 12 issue subscription will now cost \$18.00. This makes the cover price of the magazine \$1.50 per copy. The increase has been necessary due to higher costs and the general improvement of the quality of the magazine. We have been commended on a number of occasions for keeping the number of advertisements to a minimum and this must reflect back to our cover price. We will be taking on a couple of extra advertisers in this and future issues as they stock components closely suited to our requirements.

We will maintain our obligation to providing component parts for all the projects and will stock kits of parts for our 1,000's of mail-order customers.

Now, back to where I left off.

After receiving a few disapproving letters we received a number of interesting notes. The first came from a Victorian country reader who received a magazine and PC board in the mail only to find the board had been broken in two during transit. He returned the two halves to me. I have than with me now. To determine the strength of the PC material, I snapped a brand-new board in half. It wasn't easy, but it could be done. Then I stapled a board to a magazine and placed it in an envelope and tried to break it. Unless I physically stood on the magazine when it was resting on an 8cm step, the board would not break. I could not see how the board could have been damaged by our gentle postal authorities. I think we must have sent him a broken board!

The next complaint we accepted in its entirety. A remote subscriber received a board which was damaged by the stapling machine. It looked like the board had been inserted into the machine around the wrong way and the staples had damaged some of the copper tracks at the opposite end of the board. Things like this can be instantly replaced as can a board which has missed some of the holes or one of the silk screening processes. Even though every board is inspected 7 times, about 10 boards in every 20,000 manage to escape us.

Now, onto the happier side.

In issue 6 we included a couple of lines on the order form requesting you to tick your preference to the PC board. Out of the first 100 replies, 92 liked the PC idea, 8 wanted an alternative. Out of the next 100 orders, 97 liked the idea. With an incredible acceptance level like this, we can do nothing else but forge ahead with plans for the forthcoming issues.

The rate of construction has increased 4-fold since issues 5 and we can only put this down to the end of the settling-in period, and the acceptance for our method of instruction.

Learning-by-doing has been our motto. More and more readers are sending in for every project in the magazine and many readers are saying they have completed 6 or 7 projects from the 5 issues. This is exactly what we had hoped for. And it seems to be working.

## IN TWO BITS!

*Thankyou for issue number 6 of Talking Electronics. Please find enclosed the PC board for the HANGMAN. When it arrived here, it was in two pieces. The post office here always doubles over large envelopes before they go into the postman's mail bag. Consequently I suggest you place "DO NOT FOLD" on the outside of the envelopes. You could also fold each issue in half and then send them in smaller envelopes. My subscription has run out and I intend to renew if you replace this PC board for me.*

CDS Lindsay  
Frenchville, 4701.

Your comment has been noted. We will be turning the PC board at right angles for future postings to avoid the dangerous practice of halving the large envelopes.

□□□□□□□□

*I recently took out a subscription to your magazine as I feel your original approach to producing an electronics magazine results in a balance of theoretical and practical instruction which should be of value particularly to those just starting in electronics.*

*Your idea of attaching a PC board to the magazine has its good points, but I feel these are negated by the tripling in price. This may discourage many from purchasing the magazine - particularly if one does not wish to construct the cover feature.*

*If, however, you continue with this practice, may I suggest that you consider the orientation of the board when attaching it to the magazine. For magazines passing through our postal services, it is common practice to fold magazines along their longer axis. As you can see by the enclosed board it is detrimental to its 'health'. A possible solution is to attach the board down the side of the magazine.*

*Keep up the good work.*

Peter J Schafer,  
Coburg, 3058

□□□□□□□□

*I am a subscriber to your magazine and I think it is first-class. On receiving issue 6 in the mail, I was dismayed to see that the price had risen over 300% with the inclusion of a PC board. That is a cost of \$2.55 for the PC board. Most of your PC boards cost that much anyway. Even though the PC board is supplied, it is still neces-*

*sary to send away for the parts. So what is the advantage? Don't forget, some readers may not wish to build the project and the \$2.55 is wasted. I think it would be a good idea to have some magazine without the PC board. Subscribers could then have a choice.*

Derek Bovill  
Ferry Grove, 4055

□□□□□□□□

The next letter comes from one of our earliest of writers. Mr Baitech wrote to us during the second or third issue and brought our attention to the preferred method for drawing resistor symbols. Once you are exposed to both representations, you take very little notice whether they be 'box-like' or zig-zag. We will continue to present both symbols in the magazine.

Dear Sir,

*Thank you for the reminder note in with issue 6 of TE. And since I would not want to miss any of the future issues under and circumstances, I am enclosing my cheque for \$16.50 (being subscription \$14 plus \$2.50 for another PC board.*

*I wish to congratulate you on your journal. It is constantly improving in content and quality. Your technique of using freehand presentation on 5mm grid paper is most effective and quite acceptable as well as being economical. It's ideal for those who want to learn quickly.*

*I am also very pleased with the quality of your drawings both free hand and otherwise and am delighted to note that subsequent to our correspondence of some time ago, you have nearly entirely changed over to the modern way of showing "box-like" resistors and "no bridges" for crossing wires. As you said most appropriately on pages 7 and 11: "There is no short-cut to knowledge" and "You can't turn the clock back, but you can wind it up". I wish you every success with your journal.*

Theo Baitech,  
Seven Hills, 2147.

It's nice to keep in communication with readers. It's little pointers like the one brought up by Mr Baitech which strengthens the value of the magazine. If you have any similar suggestion for the magazine, please send them in. Later, in these Letters Pages, you will see our next topic for discussion. Producing a suitable electronics syllabus. It's in these fields that we can help so much.

## FROM A 14 Y.O.

I am writing this letter to state my thoughts and those of many young electronic enthusiasts (10 to 15 years) who feel they can no longer afford your magazine at the increased price.

I think your magazine is great for all ages. It out-classes all other electronic magazines which I have read. The fast and efficient mail-order is terrific. I have already used it to buy a couple of projects. I'm sure that including a PCB is great for adults, but for kids like myself, we save for weeks to buy one kit and it slows us down if we have to pay out \$3.75 for the instructions.

I have always looked at your magazine as one that can be understood by younger people, therefore increasing our knowledge of electronics, but now I feel you join other electronics magazines by increasing its cost and making it unaffordable.

Is it possible to arrange a subscription for the magazine without PC boards? Then if we like the project, we can buy the board.

I realize young readers such as myself constitute only a very small portion of your readership and possibly this letter will end up in the waste bin. But it will be some up-and-coming electronic enthusiast who will some day take your place.

Robert Connolly,  
Blaxland, 2774

It was the last sentence which frightened me. I thought if I threw the letter in the waste paper bin, I would be haunted by the possibility of becoming redundant.

Don't you think I have considered the younger reader and the newcomer to electronics in every page of the magazine? Why, even the price of the kits and printed circuit boards has been kept at a level which everyone can afford. I consider \$2 to \$3 per week is average allowance for spending on a hobby and since TE comes out only every 2 months, the \$3.75 is very good value. And now you have 2 choices.

□□□□□□

Dear Sir,

I have just received issue number 6 of your magazine. Without prior notice or approval I have been debited 2 issues to pay for a PC board which I do not want. How many other subscribers are in this same situation? Surely you realize that every person who reads or subscribes to your magazine is interested in different articles and in constructing different projects.

I have enjoyed your magazine immensely since it came on the market and it is probably the only construction magazine of its type produced in this country. It is because of my regard for the magazine that I have taken the time to write as I would hate to see it fall by the wayside by being outpriced.

Since the second issue I have constructed several of your projects. Those which I was interested in. The time delay in waiting for parts for these projects was short and of little consequence. Other projects I have not constructed because they did not appeal to me. Now you are telling me that each issue will include a PC board whether I want it or not.

Regardless of the cost saving by buying bulk, what good is a PC board to someone who doesn't want it? If readers want to buy the board, let them buy it.

At \$1.20, the magazine was good reading and excellent value. At \$3.75 with a surprise PC board, it is not value. Perhaps if I see it on the newsstand, which will be more than likely, I will peruse the issue and if I like the feature project, I will probably buy it. Otherwise.....

Paul McCosker,  
Wanaaring 2840

□□□□□□□□

Dear Sir,

Your magazine is certainly different to virtually any other catering for the newcomer to electronics. And in general I like what I see and read. However I do think you are making a mistake by including a circuit board with the magazine. I am sure there are many other readers who like to buy the magazine but not build all the projects you describe. I haven't built any of the projects from the magazine yet, but maybe my young son will.

I like your section on TV servicing. They are a bit like "electronic whodunnits".

I prefer resistors to look like zig zags and crossing lines to appear as loops. For simplicity I prefer to draw transistors as shown here:



NPN?

They have two lines instead of the four used in conventional drawings. One magazine used to draw them this way several years ago but it was only short lived.

In all other respects, I think your magazine is very good.

Rodney Champness,  
Benalla, 3672.

A symbol is a symbol. It does not matter how it is drawn so long as it is instantly recognised and easily drawn. Now everybody has grown up with the transistor symbol and nobody has ever challenged it before. I fail to see any advantage in the symbol you suggest however I will give you a free transistor for every reader who writes in with a preference for this symbol. And a free subscription if more than 5 readers suggest we adopt it in the magazine. Surely the fact that the other magazine you refer to ceased its use, is sufficient indication that it was not accepted.

□□□□□□

Dear Colin,

Thanks for your note re damaged "Hangman" Board. And thanks for the replacement, which truly I did not expect.

I don't think the damage was accidental. When I bought the magazine in the newsagents, it was the last one available and it was more for the technical information than the board, that I bought the issue. When I got home the project so interested me, that I decided to make it up. It was only then that I realized so many of the copper tracks were damaged. It looks as though someone has purposely taken to the board with a knife key or nail file to make a criss-cross pattern on the board. This nipped about 20 of the tracks and you will see I have soldered little pieces of wire across the tracks to restore the circuit.

My suggestion, to prevent this happening in the future, is to staple the boards to the magazine with the overlay facing outwards. But even this would not deter the enterprising vandal. At least you can repair the copper side of the board. It would be more difficult to replace the writing and, anyway, it's the top of the board you want to look neat.

Don Jackson,  
Pakenham, 3810

In issue number 7 it may well be that we staple the top side of the board outwards. The under-side is so simple in appearance that it is the top-side which looks the more attractive.

We cannot avoid vandalism and so far I have heard of only two instances of damage to the magazines. Later on, when we go to the USA, we have been warned that magazines sometimes go on sale in un-attended stands and many passers-by would consider the PC board "fair game".



Dear Sir,

Congratulations on a fine magazine. I have been trying to get into electronics for a long time, and since your magazine has been published, I can finally say I am beginning to understand what's going on. I even went as far as buying and constructing the "Simplicity Amplifier" and connecting it to the output of my TRS 80 for sound effects, and it works just great. I am using an old 9v 200mA power pak and it works well.

With your last issue, I'm afraid I did not like the PC board on the front cover, as I do not intend to make this project. I have it on computer and have played it a number of times.

If you intend to include PC boards with each issue, make them for test equipment. This will give them a wider appeal.

A J Martin,

□□□□□□□□□□

Dear Sir,

I received the Hangman Kit and the back issues of the magazine today. I must say how pleased I am with the promptness of your attention to my order.

However after checking the contents of the kit, I found a few discrepancies. In particular you did not send the 330k resistor. Maybe this was due to it being omitted from the parts list in the centre pages of the magazine. The other difference was the 470mfd electrolytic. It was rated at 10v and not 16v as suggested. I have been unable to identify the 10n greencap but I suppose it is the one marked .01k100v. The other green cap should be 1n 100v but the one I received was 50v001. If this means .001mfd, then it is 1n, but rated at 50v and not 100v as stated.

I also note the differences between the overlay on the printed circuit board and the parts list. Which list do I go by?

Finally will you tell me what TOUCH SWITCH and SHUT DOWN are, what they consist of and where they appear on the PC board.

W A T Howe,  
Brighton 5048.

Unfortunately the 330k resistor was left out of the parts list. This has been corrected and the resistor is being included in all kits. The 470mfd electrolytic can be in the range 10v to 16v without any alterations to the circuit, as the voltage at this point is purely DC and will not overload the electro.

The 10n greencap can be marked as .01 or 10n. The voltage rating is not important as we are nowhere near its maximum rating. For the electrolytics, you should use the parts as presented on the overlay. The final sizes to use are 3 at either 2u2 or 3u3 or 4u7 and only one at 22mfd. It does not matter which value of the smaller types you use as they are purely intended to provide a delay in the circuit or a low frequency oscillator to flash the LED in the head.

The TOUCH SWITCH and SHUT DOWN are made from two pieces of parallel wire. They can be seen on the lower end of the board near the staple holes. In operation, they use the resistance of your skin to pass a voltage to operate the circuit. Depending on the resistance of your skin, the Hangman will respond to the slightest touch if your finger is moist.

□□□□□□□□□□

Dear Sir,

I would like to thank you very much for producing a very informative magazine.

I purchased two PCB's recently, one for the four transistor amplifier and one for the square wave oscillator. I have subsequently built both units using components from my 'junk box' and am extremely pleased with the results.

My most recent project is the Hangman game and I think it is very sneaky forcing people to build it by supplying the board. I had trouble getting LED No 8 to flash until I soldered a 330k resistor between the slider of the trim-pot and the junction of the base resistors in the transistor staircase. This resistor takes the place of the 390k resistor shown in the circuit diagram. Now LED 8 oscillates when LEDs 14 and 15 are illuminated.

David Richards,  
Prospect, 5082

□□□□□□□□□□

Dear Sir,

I commend you on your insight into the need for your magazine, and its superb content. Many of my students buy the magazine and I have found your notes on "Designing Power Supplies" and your "10 Minute Digital Course" of great value to my senior physics class. I personally thank you for allowing copying of these articles - a pity more institutions do not see the need for concessions to schools and other teaching bodies.

The reason for my letter was prompted following your invitation for comments regarding the attachment of PC boards to each

issue. I initially balked at the prospect of paying \$3.75 for the magazine. Both my students (who incidentally are members of our electronics club) and I usually make our own boards, and I have found payment for a board I may not use, has forced me to rethink about buying the magazine.

I appreciate your concern for people who have difficulty purchasing the boards, but merely wish to express an alternative opinion. Is it possible to market some magazines without the board? Maybe you could supply some outlets with both the magazine and PC board while leaving the bulk of the copies at news-agents at the lower price.

Thank you for your well written articles and I wish you success with future editions.

Warren Holland,  
Seven Hills, 2147.

□□□□□□□□□□

Dear Sir,

I recently constructed the Simplicity amplifier from issue 5 of TE. I also constructed the Square Wave Oscillator from issue 3 and the 1 amp Power Supply. When I connected these three projects together to test the amplifier, I had a little trouble obtaining an output signal from the amplifier. I decided to test the amplifier with my multimeter and left all the components as they were except for the flying lead of the oscillator, which I disconnected.

When I placed the lead of the multimeter on the 2k2 resistor (the end closest to the LM 380), I was amazed to hear music coming from the speaker. For some reason I had picked up the local Geelong radio station, 3GL. Could you please explain this phenomenon.

□□□□□□□□□□

Dean Jones,  
Geelong

The multimeter is acting as an antenna and all that is required is to provide a diode somewhere in the front end and you will be able to pick up radio stations. The multimeter has a set of diodes included in its circuitry for rectifying AC and the chip possibly has a set of diodes in the input as protection. Any one of these will be sufficient to produce a signal.

Dear Sir,

I have never written to an electronics magazine before but I feel so strongly about your publication that I am compelled to express my thoughts.

You are to be congratulated for producing the best electronics magazine I have ever read.

Since I began my hobby of electronics about 15 years ago, all my knowledge has been acquired from magazines. These have included Australian, English and American. TE is the best yet.

Putting it concisely, these are the features of your publication:

1. Value for money.
2. Clear, easy-to-follow explanations of how projects work.
3. Far fewer advertisements.
4. The variety and number of projects. They are useful and educational, catering for all levels of ability and interest.
5. Layout of the pages, especially the sayings in the margin.
6. Most important of all, the PC board on the front cover.

Within a day of buying the magazine, I had built the 'Hangman'. As I am a Primary School teacher, it will be used during occasional spelling lessons to add variety and interest.

Now for some requests. Could you please give the pronunciation of words used for electronic components. It was not until I read the 10 Minute Digital Course, in issue 6 that I discovered that a 555 timer is called a 'triple five'. Could you give the pronunciation of Zener as in Zener diode? Is it Zener or Zeener?

(It is Zennner.....ed)

I would like to join a local branch of your electronics club if it can be established. Although I have been interested in electronics for a long time, my knowledge is rather limited - as I found when doing your tests.

Finally, keep up the standard, it takes me far longer to read TE than any other magazine because it is crammed with such fascinating articles. In other mags I usually read a few articles and skim through the rest. Yours makes me think.

D J McEwan,  
82 Glyde St.,  
Albert Park, 5014.

\*\*\*\*\*

Dear Sir,

Could you please make your forthcoming editions all the same size, as fitting them into the binder becomes difficult with one long magazine and the rest short. Anyhow, keep the magazines coming, they are excellent.

Robert,  
Coburg, 3058.

\*\*\*\*\*

Dear Sir,

I thank you for publishing my circuit (Binary HIGH-LOW game, page 60 issue No5.) After being informed that the project would be published, I took a copy of it to an interview for an Apprentice Telecommunications Technician, with Telecom. I wouldn't say that the project got me the job, but I don't think it hurt.

Peter Fyffe,  
Belmont, 3216.

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Dear Colin,

I am one of those older, recently retired people who, three months ago, didn't know that a 'tranny' did what valves used to do, because I didn't know what valves did anyway.

I don't like to bother you over such trivial queries but being a beginner I need each component to relate to the circuit diagram. With the Noise-A-Tron, I couldn't make the layout and parts list tally with the circuit. The component value seem to differ. Are these values critical and if I begin to experiment with different values, will I damage the IC or the transistor? I enjoyed my unit so much, I intend to make a couple more for the Grandchildren.

P J Ohlson,  
Wantirna, 3152

The reason for the differing values was due to the 3 different models we constructed. They all gave out a different range of noises and it seems the various artwork departments used the different models as a sample. Almost all the values can be substituted for other values, and the unit will function perfectly. The values will not damage the IC or the transistor while the Noise-A-Tron is producing an audible note.

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We have had a number of requests from readers wishing to be listed in the club roll. Here is a list of those we received this month. If you would like to be included in the listing, just send your name and address to us with your next order etc. If someone in this list lives near to you, you may like to drop him a line. No-body knows much about electronics so don't feel embarrassed. The more you strive, the more you achieve. This also means getting out from within yourself and exploring new contacts. All you need do is send some details of what you have been doing and mention your successes and failures. It's always nice to send a stamped, addressed letter for a reply.

Ken Pert,  
5 Paringa Pl.,  
Menai, 2232.

Colin Davis,  
4 Laidlaw St.,  
Henley Beach, 5022

Ron Brown,  
8/1434 Gold Coast Hwy.,  
Palm Beach, 4221.

## TE NOW IN NZ!

We are currently in the process of arranging a distributor in New Zealand to handle our Magazines and Printed Circuit Boards. They have already received a shipment of Talking Electronics items and all New Zealand readers are encouraged to send to:  
BC ELECTRONICS,  
6 TYRONE St.,  
BELFAST,  
CHRISTCHURCH,  
NEW ZEALAND.

Your contact at BC Electronics is Vic Stevens. You will be able to pay for the PCB's and magazines in NZ currency and you will have to add 25% onto the total of your order to cover the exchange rate. Of course you will need to add post and pack according to the items ordered. At the moment he has 5 of every board including the DESIGNER SERIES. He will also stock kits of components for most of the projects and you will receive a list of prices for the kits when you send an order for the PC boards. Magazines will cost NZ\$2 each for issues 1 to 5. Project books are available at NZ\$5 for issue 1 and NZ\$5 for issue 2. These books contain a PC board stapled to the cover, just like issues 6 and 7 of TE. Give BC Electronics your support. We have had so many requests for a supplier in NZ and now this is your opportunity to get speedy service without the hassles of getting an overseas money order.

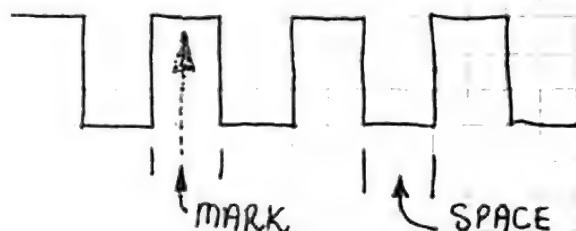
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We have also receive another helping-hand from Dennis Burchill. He is prepared to make up printed circuit boards on a on-off basis for TALKING ELECTRONICS readers in NZ. He will offer a speedy service for anyone requiring a special PC board. He hopes to be as low as \$3 to \$4 for a medium sized board and will be pleased to quote on any board you require. He can be contacted at:  
Dentronic Enterprises,  
Box 56195,  
Dominion Rd.,  
Auckland 3,  
New Zealand.

# 49

BECOMES CONNECTED TO THE NEGATIVE RAIL VIA CIRCUITRY INSIDE THE IC SO THAT THE CAPACITOR BEGINS TO DISCHARGE VIA  $R_2$ . AS THIS OCCURS, THE VOLTAGE ON PIN 2 IS REDUCING TO A POINT WHERE IT BECOMES  $\frac{1}{3}$  OF THE SUPPLY VOLTAGE. PIN 2 DETECTS THIS AND TURNS THE IC ON AGAIN. IT REMOVES THE SHORT ON PIN 7 SO THAT THE CAPACITOR  $C_1$  CAN CHARGE UP AGAIN. DURING THIS CHARGING PERIOD PIN 2 HAS NO EFFECT ON THE CHARGE-TIME AS IT IS VIRTUALLY DISCONNECTED. IN SUMMARY, THE IC TRIGGERS BETWEEN 2 VOLTAGE LIMITS TO PRODUCE A SQUARE WAVE OUTPUT.

$R_2$  IS AN ESSENTIAL PART OF THE SQUARING OF THE WAVEFORM. TO ACHIEVE AN EQUAL 'MARK'-'SPACE' RATIO,  $R_2$  MUST BE MUCH LARGER THAN  $R_1$ .

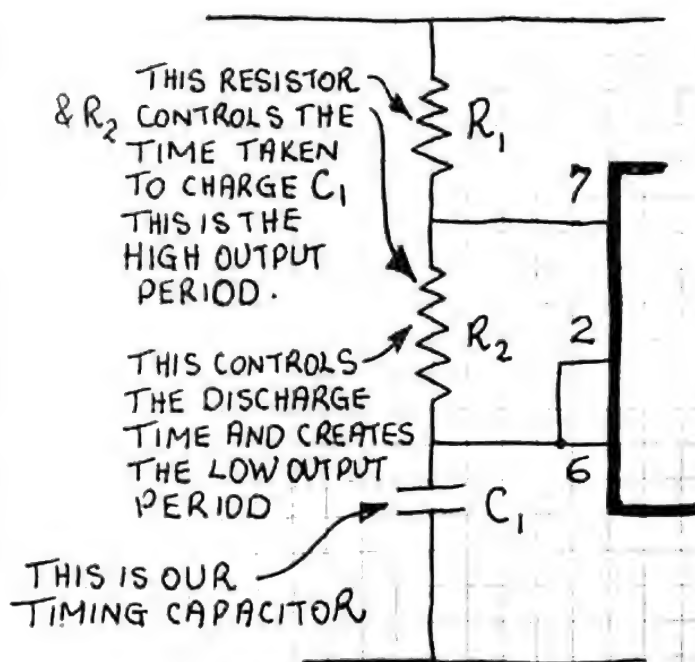


SQUARE-WAVE OUTPUT WITH LARGE  $R_2$ .

WITHOUT  $R_2$  (AS IN THE SIMPLE 555 CIRCUIT) THE MARK PULSE BECOMES VERY NARROW.



'MARK' VERY NARROW WITH  $R_2$  REMOVED.



THE TIME OF THE HIGH PERIOD IS:

$$T_H = 0.7(R_1 + R_2)C_1$$

THE TIME OF THE LOW PERIOD IS:

$$T_L = 0.7(R_2)C_1$$

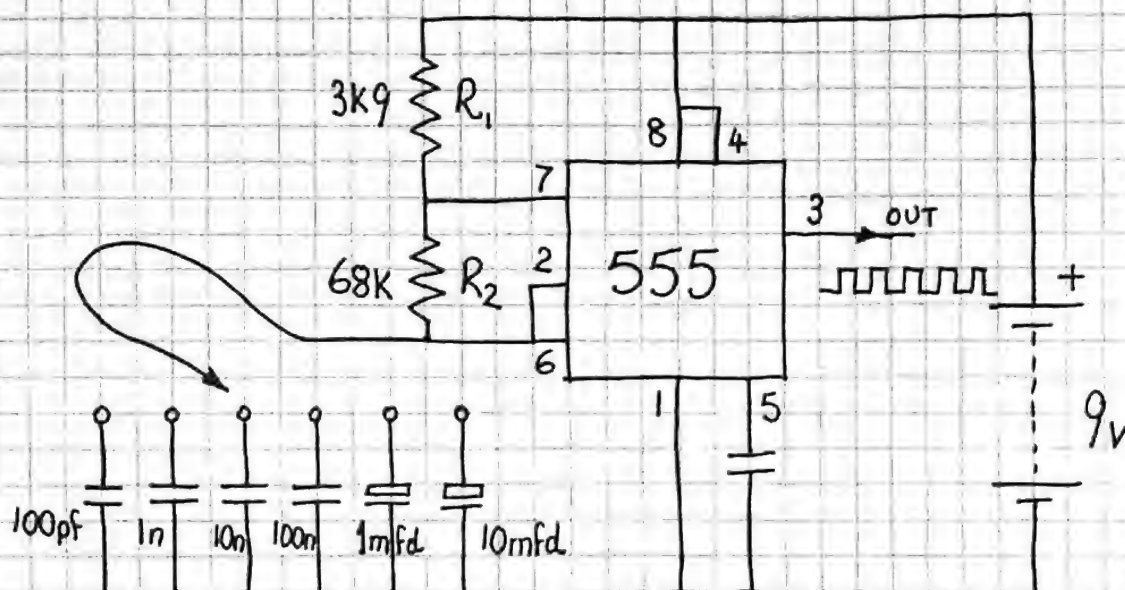
$T$  IS IN SECONDS  
 $R_1$  IS IN OHMS  
 $R_2$  IS IN OHMS  
 $C_1$  IS IN FARADS.

$$1\text{MFD} = 10^{-6}\text{ FARAD.}$$



## 555 Square wave oscillator

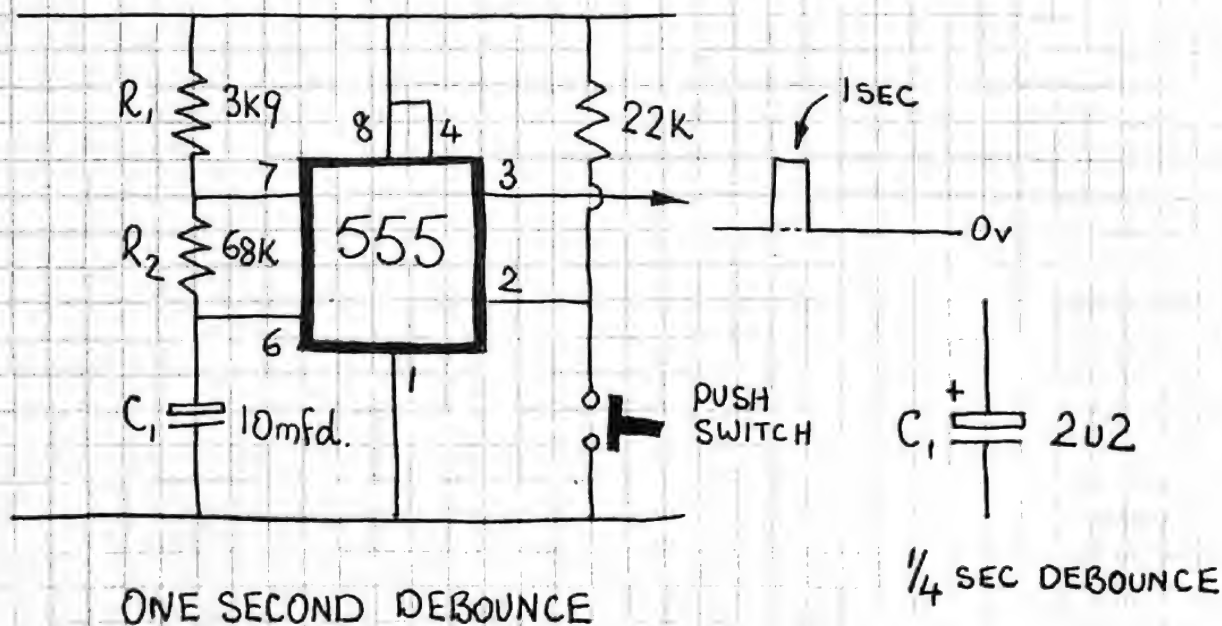
A 555 CAN BE USED AS A CLOCK WITH 6 RANGES FROM 1 Hz TO 100 KHz.



FREE RUNNING MULTIVIBRATOR

## 555 "ONE SHOT"

A 555 CAN BE MANUALLY TRIGGERED VIA A SWITCH TO PRODUCE A PULSE OF ANY LENGTH AT THE OUTPUT. THE SWITCH IS EFFECTIVELY "DEBOUNCED" & MUST BE RELEASED TO PRODUCE THE NEXT PULSE. THE CIRCUIT WILL NOT OSCILLATE EVEN IF THE SWITCH IS KEPT PRESSED.



ONE SECOND DEBOUNCE

1/4 SEC DEBOUNCE

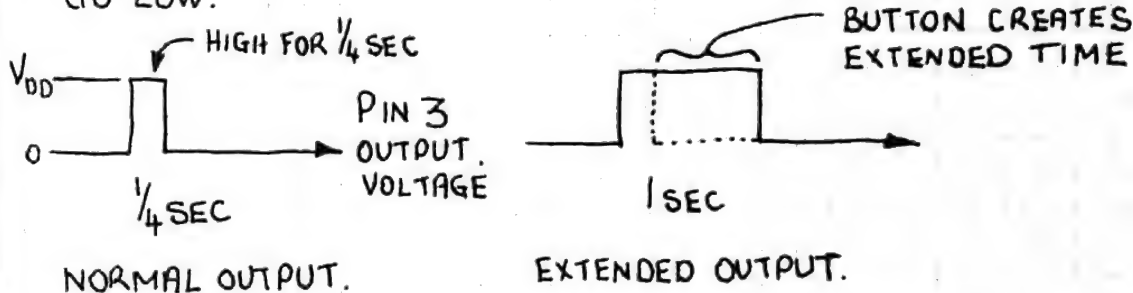
555 "ONE-SHOT"

IN THE 555 ONE-SHOT CIRCUIT, THE IC IS SITTING IN ITS "READY" CONDITION (QUIESCENT STATE) WITH ZERO VOLTAGE ON THE ELECTROLYTIC AS PIN 7 IS LOW, PIN 3 IS TURNED OFF AND PIN 2 IS HIGH VIA THE 22K. WHEN THE PUSH BUTTON IS PRESSED MOMENTARILY - PIN 2 GOES LOW - THEN-HIGH. THIS STARTS THE TIMER BY FLOPPING THE FLIP-FLOP WHICH TAKES THE SHORT-CIRCUIT OFF PIN 7 (VIA THE TRANSISTOR INSIDE THE 555) AND ALLOWS THE ELECTROLYTIC TO GRADUALLY CHARGE VIA RESISTORS  $R_1 + R_2$ . PIN 6 DETECTS WHEN THE ELECTRO REACHES  $\frac{2}{3}$  RAIL VOLTAGE AND TURNS THE IC OFF. PIN 7 IS SHORTED TO DECK VIA THE INTERNAL TRANSISTOR. THE ELECTRO DISCHARGES TO ZERO, READY FOR THE NEXT CYCLE.

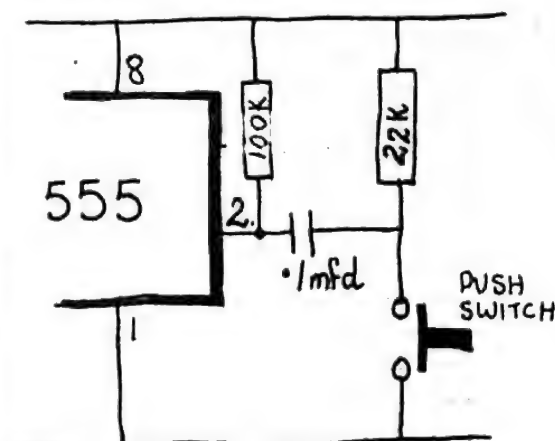
3 QUESTIONS NOW ARISE.

1. WHAT HAPPENS IF YOU PUSH THE BUTTON FOR A LONG TIME ?
2. WHAT HAPPENS IF YOU PUSH THE BUTTON AGAIN, BEFORE THE ELECTRO HAS FULLY DISCHARGED ?
3. CAN THE CIRCUIT BE MADE INTO A TIMER ?

1. IF THE "ONE SHOT" IS SET FOR  $\frac{1}{4}$  SEC DEBOUNCE AND YOU PRESS THE BUTTON FOR 1 SECOND. THE OUTPUT WILL STAY HIGH FOR 1 SECOND, THEN GO LOW.



BUT THIS OPERATION WILL LOSE THE GUARANTEED DEBOUNCE EFFECT OF THE CIRCUIT DUE TO PIN 2 BEING KEPT IN OPERATION WHEN THE VOLTAGE ON PIN 6 IS ABOVE  $\frac{2}{3}V_{DD}$ . THE CHIP WILL RESPOND TO BOTH 2 & 6 VOLTAGES SUCH THAT THE NOISE FROM THE SWITCH WILL TURN THE CHIP ON-AND-OFF AS SHOWN LATER IN THIS COURSE WHEN THE 555 IS USED AS A TRIGGER.



TO AVOID THIS SITUATION, A 0.1mfd CAPACITOR IS FITTED BETWEEN THE SWITCH AND THE INPUT PIN. THIS WILL ALLOW ONLY A SPIKE FROM THE CAPACITOR TO START THE TIMER. (WHEN WE SAY SPIKE - WE MEAN THE SMALL AMOUNT OF CHARGE STORED IN THE CAPACITOR OR THE SMALL CHARGE REQUIRED TO FULLY CHARGE IT).

PIN 2 IS KEPT HIGH & PREVENTED FROM FLOATING VIA A 100K RESISTOR.

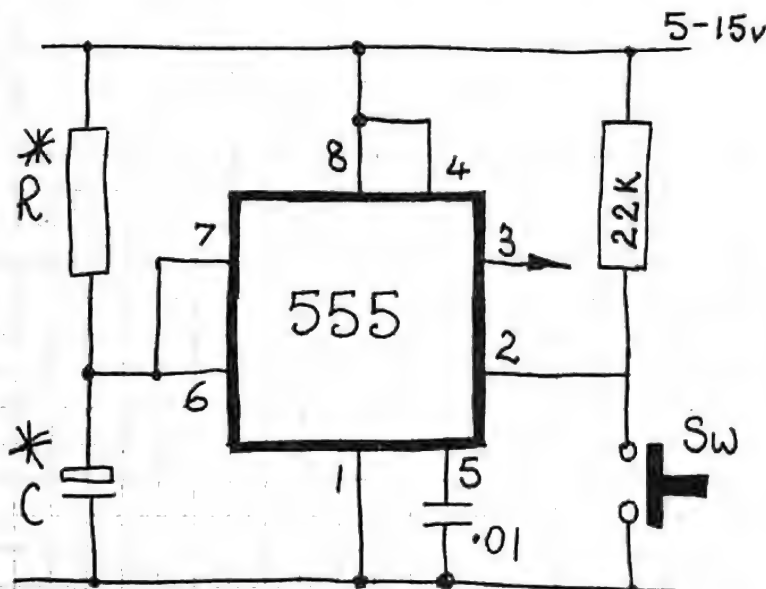
52

2. IF YOU PRESS THE PUSH BUTTON AGAIN, BEFORE THE ELECTROLYTIC HAS FULLY DISCHARGED, THE TIMING CYCLE WILL BE REDUCED. IN FACT, IF YOU PRESS THE BUTTON REPEATEDLY, YOU WILL LOSE THE DE-BOUNCE FEATURE COMPLETELY.

3. BY INCREASING THE VALUES OF  $R$  &  $C$ , THE 555 CAN BE MADE INTO A TIMER.

### THE 555 AS A TIMER

THE 555 CAN BE WIRED AS A MONOSTABLE FOR PERIODS OF TIMING UP TO 2 HOURS. THESE LONG DELAYS ARE NOT DESIRABLE AS WE ARE RELYING ON VERY SMALL CURRENTS TO CHARGE AN ELECTROLYTIC OVER A LONG PERIOD OF TIME. WITH THE AGING OF AN ELECTROLYTIC, THESE CURRENTS CAN EQUAL THE LEAKAGE CURRENT WITH THE RESULT THAT THE ELECTRO NEVER REACHES  $\frac{2}{3}V_{DD}$ . KEEP 555 TIMING INTERVALS TO BELOW 10 MINUTES FOR RELIABILITY AND USE THE FOLLOWING CIRCUIT:



TIME SECS	$R^*$	$C^*$
$\frac{1}{10}$ SEC	100K	1mfd
$\frac{1}{2}$ SEC	470K	1mfd
$\frac{1}{2}$ SEC	47K	10mfd
1 SEC	1M	1mfd
1 SEC	100K	10mfd
10 SEC	1M	10mfd
30 SEC	1M	33mfd
60 SEC	560K	100mfd

PIN 5 SHOULD BE BY-PASSED WITH A .01mfd CAPACITOR TO PREVENT THE 555 PICKING UP NOISE PULSES DURING THE TIMING CYCLE.

YOU WILL NOTICE THE TABLE OF VALUES IS FAIRLY LINEAR FOR THE TIME DELAYS. ANYTHING ABOVE 1 MINUTE REQUIRES A HIGH VALUE RESISTOR AND/OR A LARGE ELECTROLYTIC. LOW-LOSS ELECTROLYTICS ARE EXPENSIVE AND DIFFICULT TO OBTAIN.

THE USE OF ONLY 1 RESISTOR IN THE TIMING CIRCUIT ENSURES THAT THE ELECTROLYTIC IS DISCHARGED FULLY AT THE END OF THE TIMING CYCLE, READY FOR THE NEXT PRESS OF THE BUTTON.

THE CIRCUIT CANNOT BE RE-SET HALF-WAY THRU THE TIMING CYCLE.



**XX**

**How a tech with only two tool-boxes, one book and a torch, can fix almost any set, with any fault in-the-home, is not a mystery at all - it's GENIUS!**

**XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX**

Although I have used the term KICK-START, the horizontal oscillator in a Kriesler set can be more appropriately referred to as having a QUICK-START from the power supply. This is because the voltage does not fall to zero as with most kick-start arrangements.

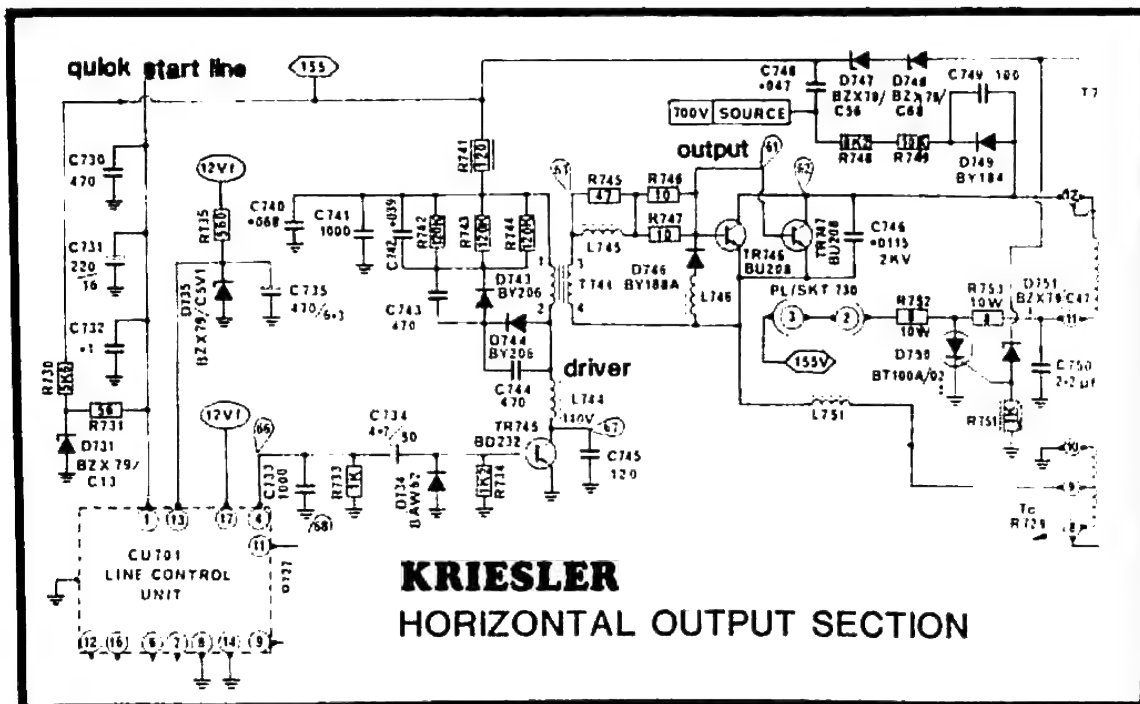
My next point of concern was the driver transistor. The 4u7 electrolytic has a history of going low and creating some unusual faults. So it was replaced. But to no avail. The set still remained dead. Next I decided to test the driver transistor. The voltage on either side of the 120R resistor was the same.

Sometimes a tortional twist of the board will reveal the suspect joint. This is why I stipulated darkness in my introduction. In a darkened room you will be able to see the sparks emanating from the faulty joint and this will save you hours of painstaking detection work.

So I tried it. I twisted the board and bent the board and tapped the board. All proved fruitless. The set remained dead. I soldered around the driver transformer and looked all over the board for an obvious dry joint. I even went over the EHT transformer terminations and re-soldered them. Still nothing.

board remains a mystery. Some things are set to try us. And this one did. These types of faults emphasise one of my maxims. "A methodical approach will see a job completed just as fast as a high technological approach" and will save carrying elaborate test gear.

In this particular case, a CRO would have thrown me completely off key. The output of the driver transformer would show the correct waveform and I would be completely misled. Fair enough, if I had chosen to test pin 4 of the driver transformer for a waveform, I may have twigged. But this is an



This was to be expected. The transistor was either not being driven or had an open collector-emitter junction.

To check its turn-on capability, I placed a 100k resistor on jumper leads and took one from the 155v rail. The other I touched quickly on the base. The collector voltage decreased appreciably. This was sufficient to prove the operation of the transistor.

Next I concentrated on the Printed Circuit Board. These boards are notorious for dry joints. Especially around transformers, coils and transistors. During manufacture, the dip soldering process did not leave sufficient solder on the lands and after a period of years, many of them become faulty. This is due to vibration, heat and the expansion of the component leads. The result is a fine, neat, hairline crack around the lead.

I then started to check around the BU 126 horizontal output transistor. This is where the surprise came. It didn't dawn at first. I found the voltage on the collector, emitter and base were all high. Maybe, I thought, the transistor has come adrift from its connecting leads. I tried the emitter and base leads. They were connected ok.

Because I hadn't realized the consequences of the high voltage, I went off and started to test the driver transformer. Pin 1 high; pin 2 high; pin 3 high; pin 4 high. Hey. Something is wrong here. I couldn't believe it. I knew the output of the transformer should be low. But it wasn't. Something was really wrong. I followed the circuit back from pin 4, and what did I find? One of the leads of a tiny little choke, L 751, had become dry.

All I needed do was add a little solder and the job was done. Why it didn't respond to my twisting the

unlikely point to measure as it is an earthy point.

I have used a CRO in the past for repairs and I can categorically state that it has very seldom helped me locate any of the common faults. In fact it can quite often be misleading because it is a very high impedance probe. Only patience, skill and a multimeter is needed.

The second interesting fault occurred with a GEC set. These sets are identical to ITC sets and are made in England for the Common Market. They are a well-designed set with all components mounted on modules which can be easily removed, leaving just a picture tube. This feature is ideal for a set during its initial guarantee period where a shopkeeper or repairman can change over a module and get the set operational without any technical know-how. But it falls down after the guarantee period



has run out. For the remaining life of the set, most are repaired by private technicians. Few, if any, can afford to stock a set of modules as their cost is enormous. To stock modules for just one model would cost in excess of \$200. Imagine catering for 300 different models! That's why most technicians don't offer change-over modules and prefer to repair the set in the home at the least expense.

Changing over a module is a very expensive way of going about a simple repair. It would be like all garages having a change-over engine every time you wanted a new spark plug.

With most fully modular sets, the manufacturer has given little thought to repairing a module while still attached to the set. Most often the leads connecting to the module are very short and the module positioned in an inaccessible place.

Not quite so with the GEC set. The modules can be worked-on in-situ and with only a small amount of manouvering, the PC side of the board can be attended. The only annoyance with these over-designed sets is the plate-through holes and the double sided board. At least you never get a dry joint!

The fault with the GEC set was simple. A blown 1 amp fuse. It had exploded, as evidenced by the blackened inside of the glass fuse. So dutifully, I removed the power supply and began to follow through to all the components likely to short out the power supply.

Nothing was found. Everything read ok. The bridge rectifier was ok, the main electrolytic was ok, all zener diodes were ok and the high current diodes feeding the remainder of the set were all ok. I detected a slight leakage in the BU 126 switch-mode transistor and decided to replace it.

I put the power supply back in position and fitted a one amp fuse. Bang. Something was a dead short. I removed the leads from the base and emitter of the BU 126 and switched on again. Bang.

Now this is where I got a little cunning. Since I couldn't detect the short with my multimeter, I reasoned that it must be the higher voltage which was breaking down a component. So I fitted a 2 amp fuse and tried again. Sure enough: Bang. But this time some smoke came from a little capacitor fitted

across the switch-mode transistor. It was a 2200pf 630v poly intended as a spark suppression and tuning capacitor. It had obviously cooked internally over the years and had finally started to break down. The additional current had exposed the faulty layers and blew it apart.

It was replaced with a larger unit which was designed to operate in a 15kHz situation. These capacitors are critical and must be fairly large physically to be able to handle the heat generated.

This brute-force approach does not always work. You run the risk of damaging the power supply by overloading it like this. You need to know how far to go in every situation with fuse rating before damage sets in.

**Even broken TV's have their own in-built CRO.**

**They also talk to you.**

**LOOK and LISTEN before you repair.**

The third story involves a 26 in Blaupunkt set. These early model sets are identical to Siemens sets and were all made in the Blaupunkt factory.

Servicemen love these sets. They provide a handsome return to the serviceman because they produce an enormous number of easily fixable faults. And due to the prestige of the set, you can charge the full-value for your time.

Once you have worked on a few dozen of these sets, you get to know them inside-out. This even come down to knowing the location of a component causing a short-circuit, merely by listening to the sound of the hic-cupping power supply. Yes, that's right! The power supply tick tick ticks at a different rate according to the load placed on it. Blaupunkt sets produce other noises under fault conditions. These usually come from the EHT section when some of the capacitors go faulty. I don't intend to go into the operation of a thyristor horizontal output stage in this case as it did not come into the problem. But what did are my ears.

Before diving into a fault: STOP, LOOK and LISTEN. This set needed just that. I turned the set on and up came a loud squeal, just like the horizontal oscillator running way off frequency. Listen to the squeal,

try to locate its source. But most important, sniff and smell around the set for overheating components. At first I thought it was the horizontal oscillator off frequency. Then I remembered the critical nature of many of the block capacitors in the horizontal section. In fact they are so critical that you must replace them with the exact same type of capacitor. Not only do they need to operate on high frequency but they must be capable of storing quite an amount of energy without getting overheated. Thus a physically smaller capacitor will not work. These facts I knew. I also knew that the printed circuit board suffers from dry joints around these capacitors and on the transformer connections.

So firstly I tested all the capacitors in the EHT section for shorts. They not only tested ok, but showed a charging current as evidenced by a slight movement of the needle on the multimeter when set on the high ohms range. So how could a good-quality block capacitor create a problem?

To find out, I took an ordinary polyester capacitor having a value somewhere midway in value to the units I was testing. I knew I could use an ordinary capacitor for a short period of time without any danger occurring.

I jumpered the first capacitor. No change. I jumpered the second capacitor. The squeal stopped. The value of the faulty capacitor doesn't matter. The real lesson to be learnt is not to jump to conclusions. Possibly, a few years ago, I would have worked on the wrong section for hours. Now I seem to have a bit more luck.

I took the capacitor out of the set and examined it. It had a slight crack in the case. This was either due to excess heat or high frequency fatigue and it had changed value. These capacitors are normally quite reliable. This type of fault happens very infrequently. But it emphasises the point that you cannot trust even the most reliable component.

Obviously lots more happened on the servicing side of things. I'll pick out a couple more novel approaches for elaboration in the next issue. These aren't ment to be followed to the letter. They just merely give you an insight to how sets are repaired - by hook or by crook. And it's sometimes by crook!



# Train Throttle

## PART 3

This month we present a printed circuit board for the second version of our train throttle. This circuit has several advantages over the previous version, these being overload protection and adjustable maximum and minimum voltages.

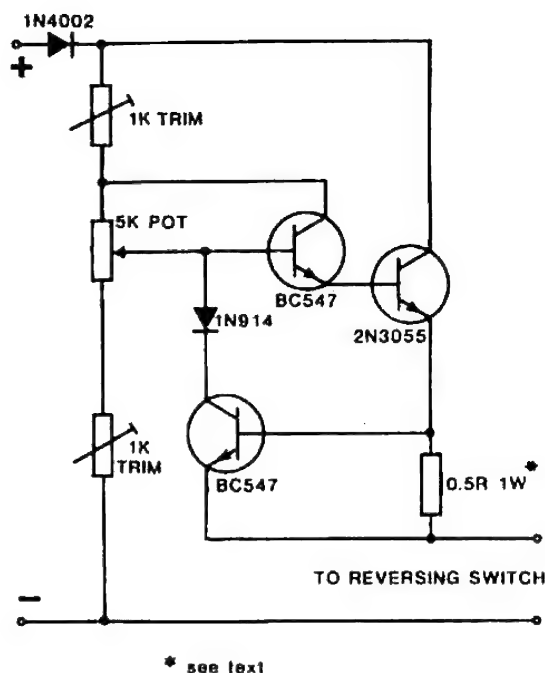
The minimum voltage sets the start-off voltage. This is used to compensate for different starting voltages of different motors used in locomotives.

The maximum voltage is set to limit the maximum speed to a realistic level as most model locomotives are capable of scale speeds well above that of their full-scale counterpart. The overload protection prevents the throttle or any other equipment from being damaged should a short-circuit occur.

There is a simple solution to overload protection which can be used with the earlier version of the throttle. And it requires very little wiring. A car headlamp bulb is wired into the positive rail, between the transformer and the positive input of the throttle. Both filaments of the lamp can be wired in parallel if you find that a normal load causes the lamp to glow. This form of protection has the advantage of giving a visual indication of an overload.

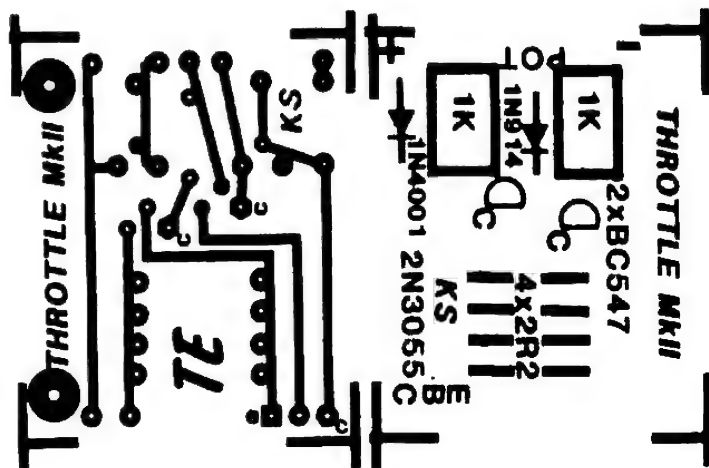
The theory behind its operation is quite simple. When cold, the resistance of the filament is only a few ohms. This has negligible voltage drop across it and does not affect the operation of the circuit. If a short-circuit is placed across the throttle, more current flows through the lamp, causing the filament to become hotter and its resistance to increase. This will cause most of the voltage to be dropped across the lamp and thus limit the output current. The lamp will also give a visual indication of the overload.

The construction of the throttle has been made simple by the use of a PCB. The components can be soldered onto the board in the usual order of resistors first; transistors last. If you are using a .5 ohm 1 watt resistor instead of four 2.2 ohm resistors, it may be mounted at an angle, across the area meant for the four resistors. Make sure you heatsink the 2N 3055 transistor because it will get very hot during overload conditions. The reversing switch is wired as in the throttle Mk I.

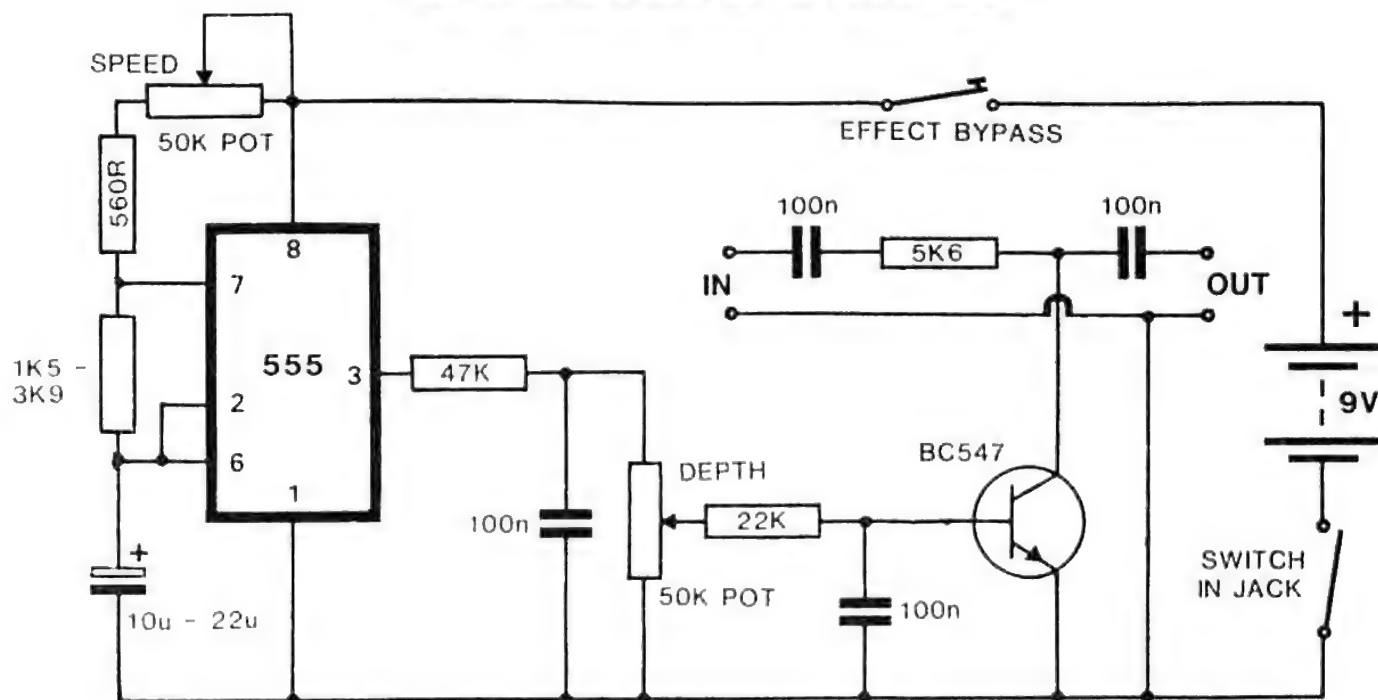


### THROTTLE PARTS LIST

- 1 - 1/2 ohm 1watt  
or 4 x 2R2 1/4watt
- 2 - 1k mini trim
- 1 - 5k pot
- 1 - 1N 914 diode
- 1 - 1N 4002 diode
- 2 - BC 547 transistors
- 1 - 2N 3055 transistor
- 1 - heatsink
- 1 - DPDT switch



# TREMOLO



## TREMOLO UNIT

**Tremolo is amplitude modulation of an audio signal. Examples you are familiar with include the electronic organ and electric guitar.**

Tremolo is like turning your amplifier up and down very quickly. Our version is more complex than this. It includes a chopping effect which changes the volume rapidly between two levels.

Tremolo was first produced by rotating a baffle in front of a speaker. This baffle had an opening in one side so that as it turns, it directs the sound firstly away from the listener, then towards him. This effect was also produced by rotating the speaker itself, but this is much more complex to engineer.

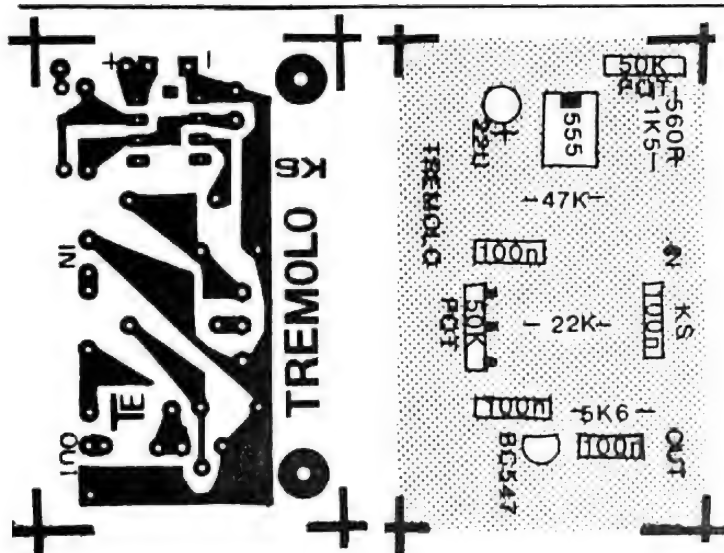
**A similar effect can be achieved quite simply using electronics. From the circuit diagram, it can be seen that few components are needed.**

The circuit can be separated into three sections, each performing a function. The first is the Low Frequency Oscillator (LFO) which is based on the familiar 555 timer. Different effects can be achieved by varying the discharge resistor fitted between pins 6 and 7 and the timing capacitor.

With the discharge resistor at 1k5, the output of the LFO is a short pulse and as it is changed to 2k2 or 3k9, the pulse becomes longer.

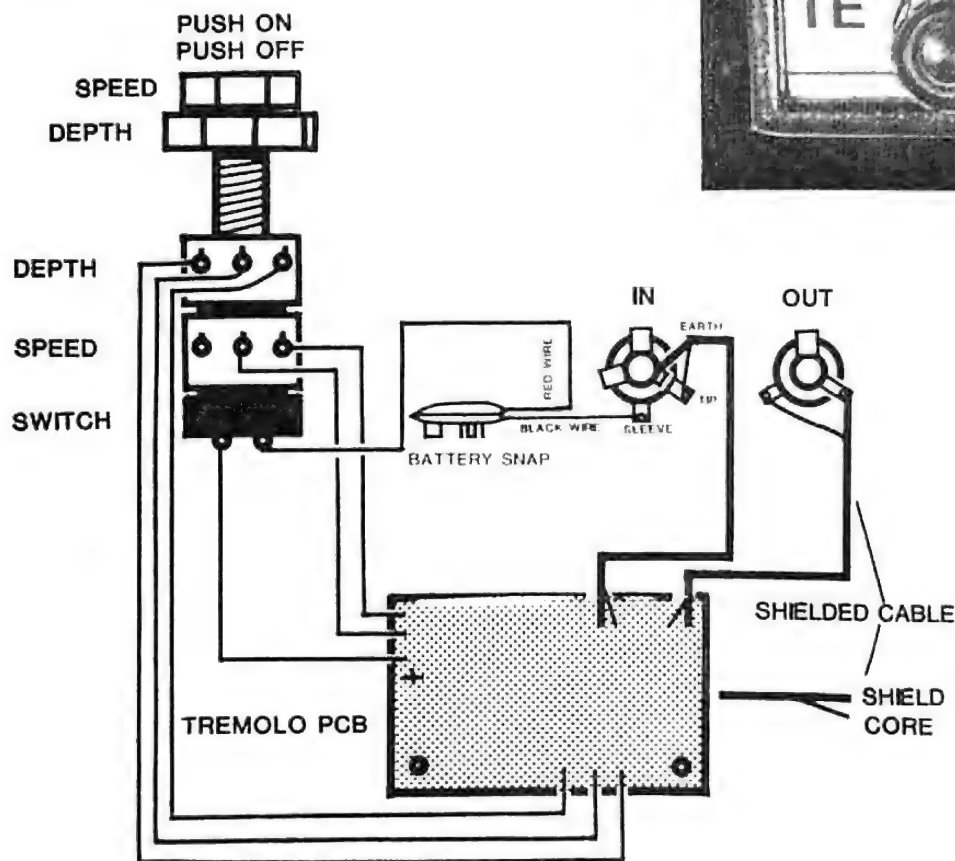
The 555 performs two functions. It generates a HIGH at the output which can be adjusted to give varying depths to the quiet period of each cycle. It also generates a LOW, which allows the signal to pass through the unit unattenuated. The maximum speed is altered by changing the value of the 22 mfd. If a 3k9 resistor is used in the discharge circuit, the 22 mfd electrolytic should be replaced by a 10 mfd in order to retain the fast tremolo effect.

The next section of the tremolo is the transistor switch. The transistor is wired so that when the output of the LFO goes high, the transistor switches on. The degree of "switch-on" is determined by the setting of the depth pot. When this pot is set to minimum, the pulse from the LFO is insufficient to turn the transistor on. As the setting is increased, the transistor is partially switched on by each pulse. With the depth pot set at maximum, the transistor is fully switched on by each pulse.



The third section is the audio attenuator. This consists of two 100n capacitors (for DC blocking) and a 5k6 resistor. The transistor and the 5k6 form an adjustable voltage divider. When the transistor is off, the audio signal present at the input is able to pass to the output unattenuated. But when the transistor is partly switched on, a small portion of the signal is lost.

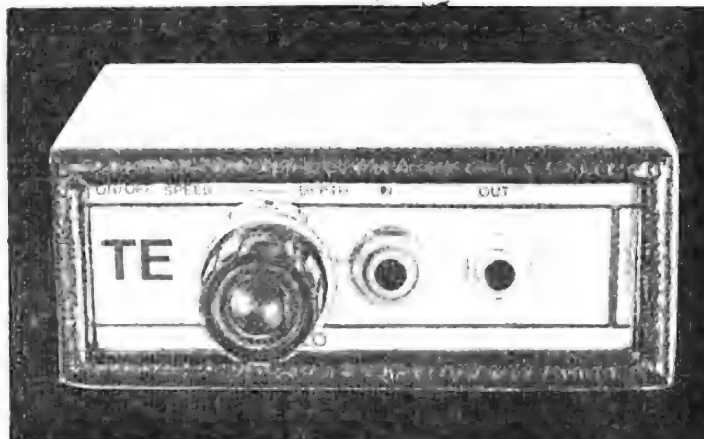
The transistor forms the bottom arm of the resistive divider. Its resistance is determined by the voltage on its base. When it is switched on by the LFO, it attenuates the signal. The percentage and depth of this attenuation being adjustable.



If no attenuation is required, the 555 and transistor must be switched off. This will allow the signal to pass without loss or modification. Construction is straight forward. Use shielded cable to connect the input and output jacks to the PC board. Connect the positive terminal of the battery to the bypass switch and the negative terminal to the "sleeve" connection of the stereo input jack. The output jack need only be a mono type. Two 50k pots and a push-push type switch can be used, or alternatively a car radio pot, which contains two pots and a switch, can be used.

The unit can be built into an aluminium case for complete shielding. Alternatively a wooden case can be used, providing the unit is kept away from any hum-producing components such as transformers. The case in the photo is made of wood, covered in a vinyl cloth. We did not experience any pick-up when testing the unit.

This project can be combined with our FUZZ UNIT from issue 6 to produce some interesting effects. This will enable you to adjust the tremolo unit to produce a rapid switching between distorted and undistorted signal.



#### TREMLO PARTS LIST

- 1 - 560R
- 1 - 1k5
- 1 - 3k9
- 1 - 5k6
- 1 - 22k
- 1 - 47k
- 4 - 100n
- 1 - 10mfd 16v
- 1 - 22mfd 16v
- 1 - 555 IC
- 1 - BC 547
- 1 - battery snap
- 2 - 50k rotary pots
- 1 - push push switch
- 1 - mono 6.5mm jack
- 1 - stereo 6.5mm jack



## USING THE DESIGNER MATRIX SYSTEM

The next five pages are an introduction to our new **DESIGNER SYSTEM**, using a matrix board. Five pages doesn't give me much space to describe 3 projects and a full introduction to the system. So, what had to go? The introduction! I was left with only half a page to introduce this beautiful new system.

Well, it's really not all that new. A Matrix board has been available on the market for a number of years and has met with a small amount of approval. But it has its limitations and draw-

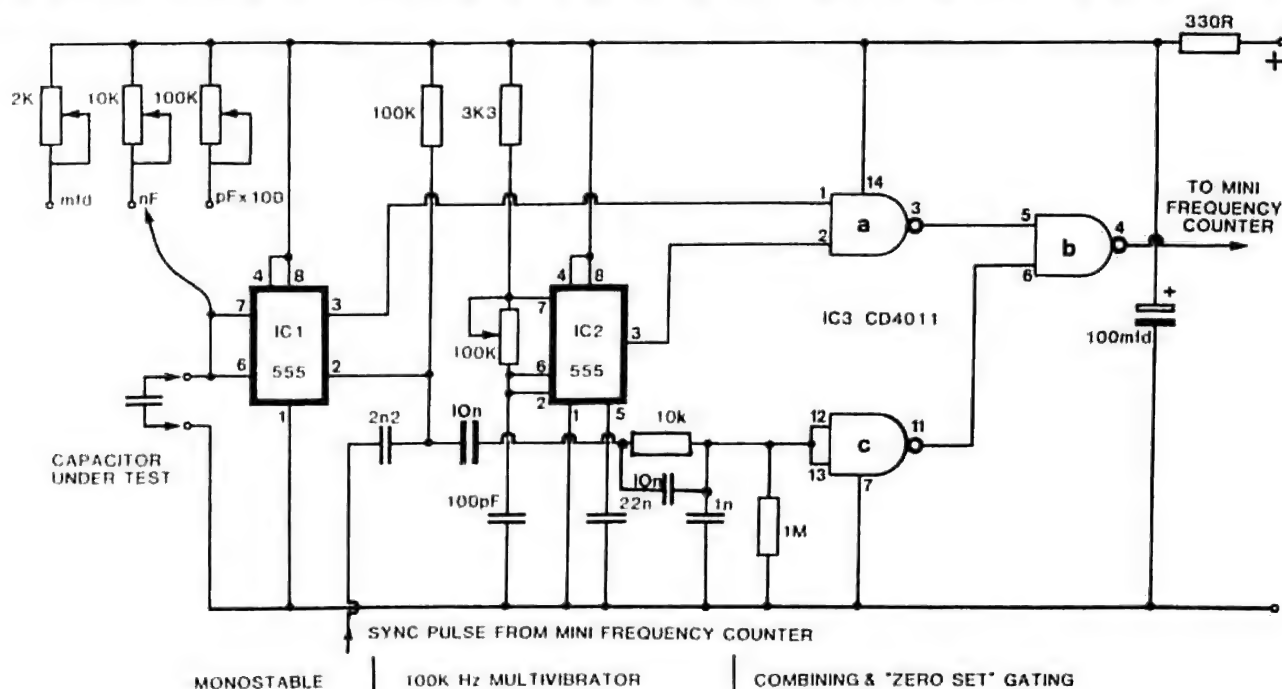
backs. In our system I have tried to eliminate these faults and I think I have been successful.

Our board is small, neat and compact. It will accommodate all types of components made for the .1" standard spacing and if you intend to make a number of modules which fit together to produce a larger project, the boards can be connected to a mother-boarding system via the edge connectors.

In all, I think you will find this new system ideal for building some of our projects. It doesn't need any strip-cutting and can be used much more efficiently than the matrix board having strips running down its length.

Our three projects had to be presented very tightly in the following pages due to the colour overlays on the last two pages. You will find some of the sections to each article have been separated because of this.

# DIGITAL CAPACITANCE METER



Last issue we mentioned we would be producing a PC pattern for the DIGITAL CAPACITANCE METER. Well, we didn't get quite that far. We decided not to go to the full pattern as we intend to release another frequency meter in the near future with an inbuilt capacitance meter using 7-segment displays. So, for cheapness, we have bread-boarded the circuit and still allowed some margin for adaption. The only modification we found necessary to the previous circuit was with the "zero set" gate. A separate network was found necessary between the input pins 12, 13 of gate 'c' and pin 2 of the monostable 555. The input protection diodes of gate 'c' tended to upset the sync pulses coming from the Mini Frequency Counter and some projects failed to give a reading. It all depended on the manufacturer of the chips.

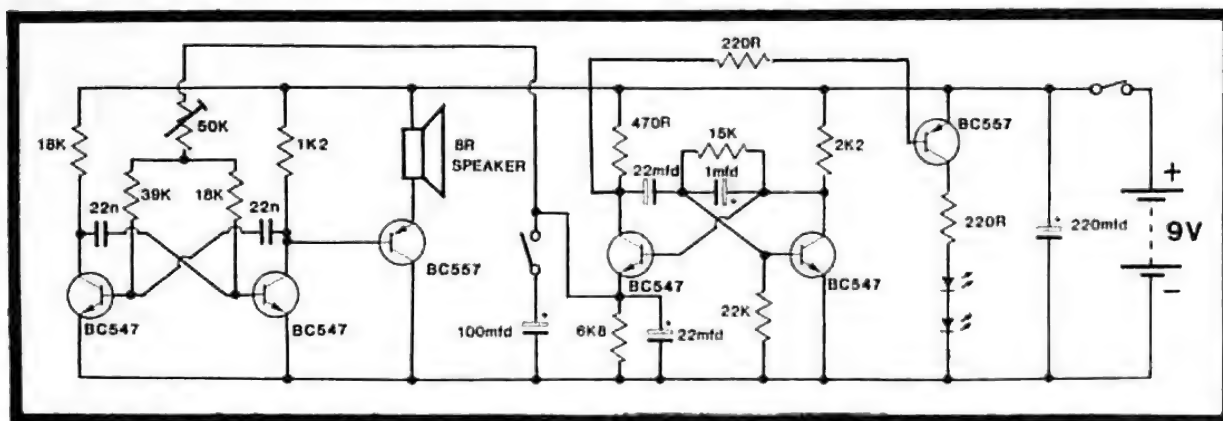
In all other respects the circuit is the same.

### SETTING UP

The 100kHz multivibrator must be set to 100kHz by using an accurate reference. You can use the Mini Frequency Counter for this task, before combining the two units. Four leads connect the two boards. Set the Mini Frequency Counter to RANGE L and connect a 6v or 9v battery. You will see three zeros on the display. This will indicate all is working. Calibrate the instrument as detailed in issue 6. Then you are ready to test all those unknown capacitors.

By adjusting the jumper lead on the Cap Meter board you will be able to test capacitors from 100pF to 10mF with over-range. (Over-range means a 15mF capacitor will read as '500' on the scale with the '1' at the front being the over-range.) The parts list, photo of completed project and layout appear on P. 66.

# PHASER GUN



We are all familiar with the type of sounds produced by home video games and pin-ball parlours. Naturally we think it requires a complex circuit to achieve such an interesting sound. But not so. The simple beating together of two widely differing frequencies will produce a quite startling range of depth sounds.

The first range of electronic organs imitated the traditional instruments and were intended to produce fairly harmonious sounds.

Then came Moog. He produced weird tonal effects by combining many different waveshapes together to get an enormous range of sounds. This was called synthesised sound. And we had years of newly-created music to fill the pop-music charts. Then came the introduction of Video games and a completely new use for electronic music emerged. They revealed such wonderful sounds as explosions, death rays, or the fall of an object from a great height.

These conjured up a complete picture within the sound and when combined with the video display, resulted in a quite dramatic effect. The video games field is only just beginning and already it is a multi-million dollar business.

New sounds and more sophisticated games are appearing almost daily. Even though the sounds may seem to be more complex, they basically stem from simple beginnings. The elements of these effects have been presented in the NOISE-A-TRON as featured in issue 4, and now the space gun effect is produced in our project:

## PHASER GUN.

This project has two controls. One sets the frequency of the sound while the switch provides fast or slow speed.

I can't give justice to the sound. You will have to make the project and hear it for yourself. But I can say it will be worthwhile. In a later project we will be producing a SPACE INVADERS game using this circuit to give realism and I think you will be quite impressed with effect.

The circuit is constructed on our MATRIX BOARD 24 x 25 and requires only a small number of components. Two control levers are used to alter the sounds and these are soldered onto two mini trim pots. One trim pot is used merely as a switch in which the resistance of the pot is so high that it does not have any effect in the operation of the circuit. When the wiper comes close to the end-stop, it acts as a switch and this action gives us the required HIGH speed, LOW speed. The PUSH-SWITCH is actually the power switch to prevent the unit being left on. After a few minutes of operation, the rest of your family will be quite aware of your presence and will be glad of the push switch.

## HOW THE CIRCUIT WORKS

The PHASER GUN is basically two multivibrators. The first multivibrator consists of two BC 547 transistors connected in an equal mark-space arrangement as evidenced by the similar value of the base resistors and the equal value coupling capacitors.

To keep oscillating, the two bases must have a voltage on

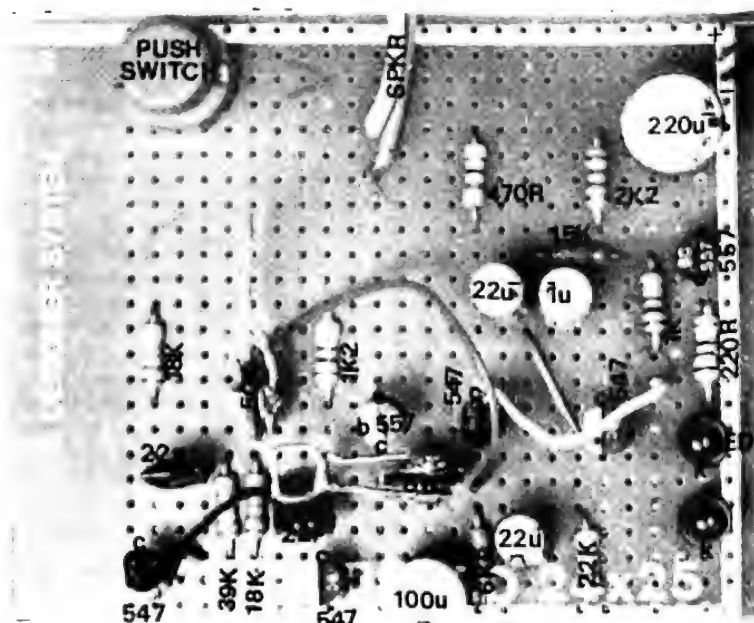
them. This is supplied via the 50k pot from the second multivibrator. When this voltage is high, the circuit oscillates at a high frequency. As it decreases, the tone is lowered. Before we move on to the second multivibrator, we can complete the first section by adding that the third transistor is acting only as a buffer so that very little load is placed on the multivibrator when the speaker is being driven.

The second multivibrator has a very low frequency. Along with the low frequency is a very uneven mark-space ratio. Something like 20:1.

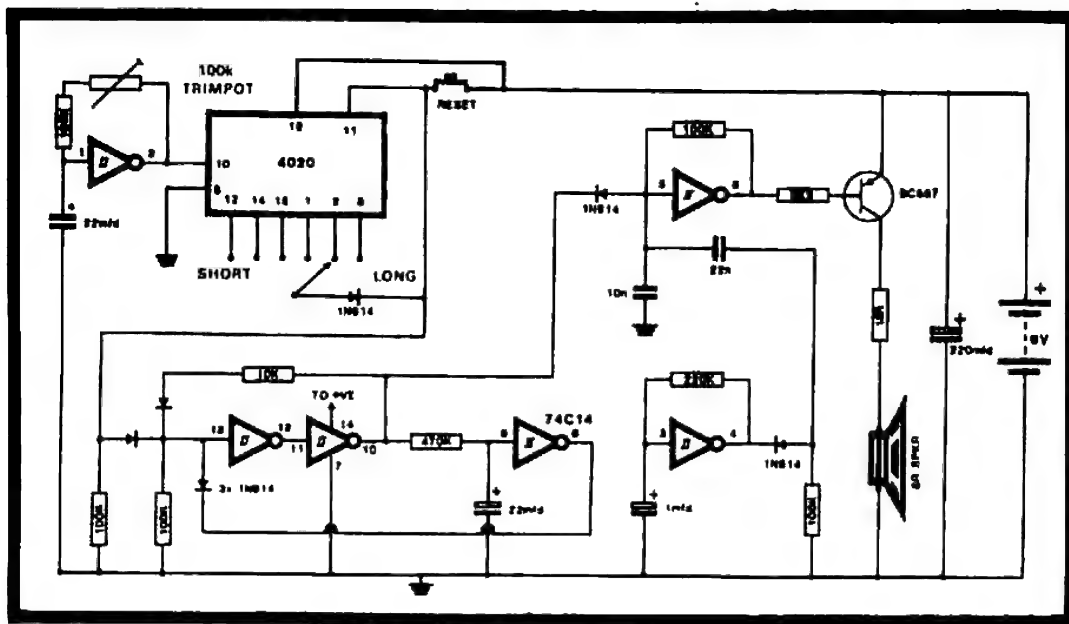
When the power is applied, the 22mfd electrolytic is charged by the BC 547 with a very short pulse of energy. It is this voltage which is fed to the first oscillator via the 50k pot. After the initial charge, a long time delay is provided so that the voltage is bled off via the 6k8 resistor and as the voltage falls, the tone is reduced. During this charging time, Q6 is turned on to pulse the two LEDs. This gives them a very short ON time.

The final sound which results is similar to an oscillator unwinding and being periodically kicked into life. By adding the 100mfd electrolytic across the 22mfd, the repetition rate is decreased considerably. Depending on the setting of the frequency control, this will have an interesting effect on the tone.

Use the layout diagram and the photo to assist in the construction. Mount all the components first and solder them onto the lands so that they are firmly in place. Take one fine strand of tinned copper wire and solder it carefully to the solder lands to create the wiring pattern for the underside of the board. Use the words THE DESIGNER SYSTEM to reference the underside with the top when turning the board over. Otherwise nothing will match up!



# PILL TIMER



**There are two things I always forget. One is to put the garbage tin out for collection, and the other is to take my medicine on time.**

What I need is a timer. One which would let me know when the time is due. This would necessitate a long-duration timer, one capable of timing from two hours to several days. And after considerable searching, I have come to the conclusion that they are not available. Every timer I could find had a maximum time of 1 hour. So I thought about designing one my self.

**I cheated a bit. I used the oscillator circuit from the EGG TIMER as featured in issue 6 and fed it into a high division binary divider, to obtain the length of delay I required.**

The result is the PILL TIMER circuit.

It is constructed on a matrix board type 24 x 25 and the parts are laid out in bread-board fashion in which the printed wiring is produced by joining the solder lands with fine copper wire. The finished result is almost as neat as a specially produced circuit board but has the advantage that it can be adapted and modified to suit your own requirements. If you buy the Matrix boards in advance, you can take advantage of the special price and you will be able to construct any of the Matrix projects as soon as the magazine appears.

We will be featuring a number of circuits on these boards in each issue and a stock-pile of three or four boards will not go a-miss.

## HOW THE CIRCUIT WORKS

The six inverters in the circuit diagram are all contained in one chip. The 74C14 is a HEX INVERTING SCHMIT TRIGGER package and the basic operation of these inverters comes from the input voltage detection. When the input is LOW, the output is HIGH. When the input rises to 2/3 of the supply voltage, the output changes to a LOW. When the input falls to 1/3 of the supply voltage, the output goes HIGH again.

**When these inverters are connected in oscillator circuits, the input is designed to swing between  $1/3$  and  $2/3$  of the supply voltage.**

Now, for the operation of the circuit:

The main timing oscillator is made up of the inverter between pins 1 and 2. Its frequency is set by adjusting the 100k mini trim pot. Using the values shown in the circuit, the oscillator produces a frequency of about 1Hz. This means the CD 4020 IC will receive one clock pulse every second. The CD 4020 is a 14 stage binary divider (counter) with 2 of the lower divisions not appearing as an

output. This means the chip will divide the input frequency by a maximum of 16,384 if the highest division is used. This number will represent the number of seconds and I worked this out to be just over 45 hours! Without any alteration to the oscillator, we have made provision for selecting 6 different time lengths, merely by altering the jumper to the molex pins. Each pin-time will be half that of the previous. If pin 3 is 45 hours, pin 2 will be 22½ hours. And pin 1 will be 11¼ hours, pin 15 will be nearly 6 hours, pin 14 nearly 3 hours and pin 12 nearly 1½ hours. Any of these timing intervals can be adjusted by altering the 100k trim pot so you have a good time-coverage available.

**This is a far cry from the 1 hour timer in the shop. With these longer times, you can be reminded to take your medicine every 4 hours or every 8 hours. You could even remind yourself to put the rubbish bin out in two days time!**

The output of the CD 4020 passes through a blocking diode and then through a gating diode to a bistable latch. This is made up of inverters between pins 13 and 12; and the next inverter with pins 11 and 10. Pin 13 is normally sitting LOW with the 100k resistor designed to stop any static charge from triggering the gate. The 100k resistor prior to this keeps the reset pin of the CD 4020 at earth potential to allow the chip to clock.

Pin 12 is sitting HIGH and this makes pin 11 HIGH. The output pin 10 will be LOW and thus the 22mfd will be sitting in an uncharged condition. Output pin 8 will be HIGH and although it feeds back into the input of the latch, its HIGH will be blocked since it is reverse biasing the lower gating diode.

With a LOW on pin 10, the top tone oscillator, made up of pins 5 and 6 will be prevented from oscillating since pin 5 must be able to swing between  $\frac{1}{3}$  and  $\frac{2}{3}$  supply voltage. The diode will only allow the pin to rise to .6v. Thus the base of the buffer transistor will be HIGH and it will be switched off. The lower oscillator will be functioning all the time the power is applied, but since it feeds into the input of the top oscillator, it will not be heard.

When the gated output of the CD 4020 goes HIGH, it makes input pin 13 of the schmitt trigger go HIGH and this will alter the state of the next inverter. This effect is fed back into the input of the two inverters to form a latch. It only takes a spike to create this latching effect and this is all the 4020 will have time to supply as it is wired to reset itself as soon as the gated output goes HIGH. With the first two inverters latched, the 22mfd electrolytic begins to charge via the 470k resistor. During this time, the top oscillator is enabled and drives the speaker. It is also being modulated by the slow frequency of the lower inverter. This gives a two-tone effect from the speaker which has a duration as set by the charging of the 22mfd electrolytic.



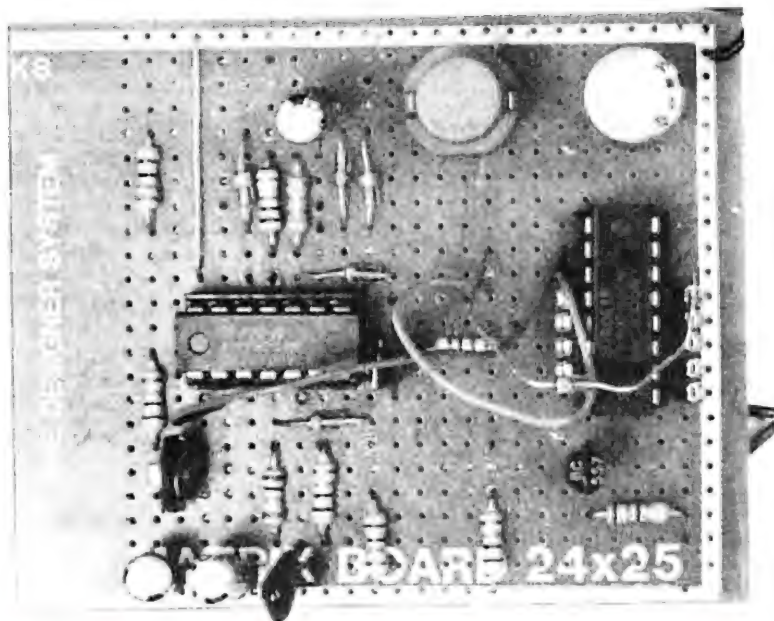
## ... PILL TIMER

When pin 9 reaches 2/3 supply voltage, output pin 8 goes LOW and pulls pin 13 LOW to reset the latch ready for the next triggering.

I would not suggest this circuit be used in any critical timing situation as the main oscillator is voltage dependent and temperature sensitive. But it will be perfectly suitable for non-critical reminder situations.

Mount the components on the MATRIX BOARD to correspond with the photo and solder the leads to the lands. This will keep all the components firmly in position. Snip all the leads short then turn the board over and produce the underside wiring, by using a length of fine copper wire.

Even the finest of wire will be suitable and is the best choice. Make sure you use the identification marks on the board so that when it is turned over, the underside wiring matches up with the top side.



## DIGITAL CAPACITANCE METER

1 - 33R  
 1 - 3k3  
 1 - 10k  
 1 - 100k  
 1 - 1M  
 1 - 100pf styro  
 1 - 1n 100v  
 1 - 2n2  
 2 - 10n  
 1 - 22n  
 1 - 100mfd 16v  
 1 - 2k mini trim pot  
 1 - 10k mini trim pot  
 2 - 100k mini trim pot  
 2 - 555 timer IC  
 1 - CD 4011 IC  
 hook-up wire

Out  
 Syn  
 Gnd  
 K8



# PILL TIMER

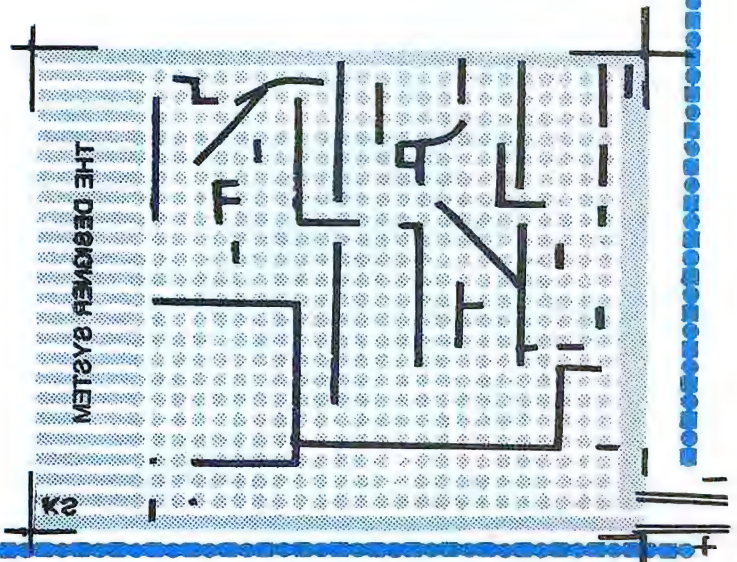
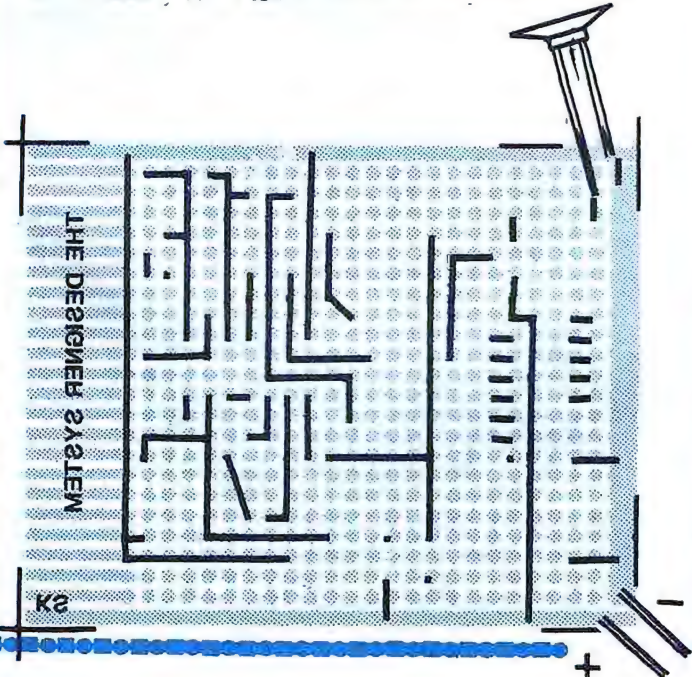
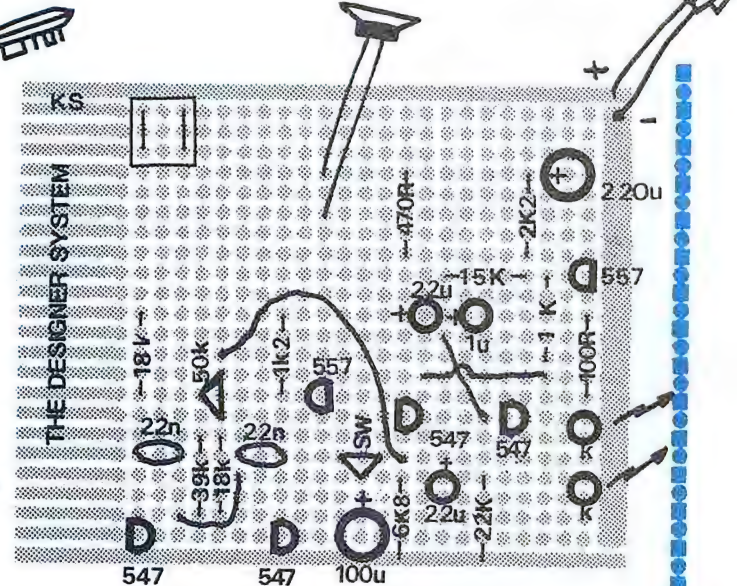
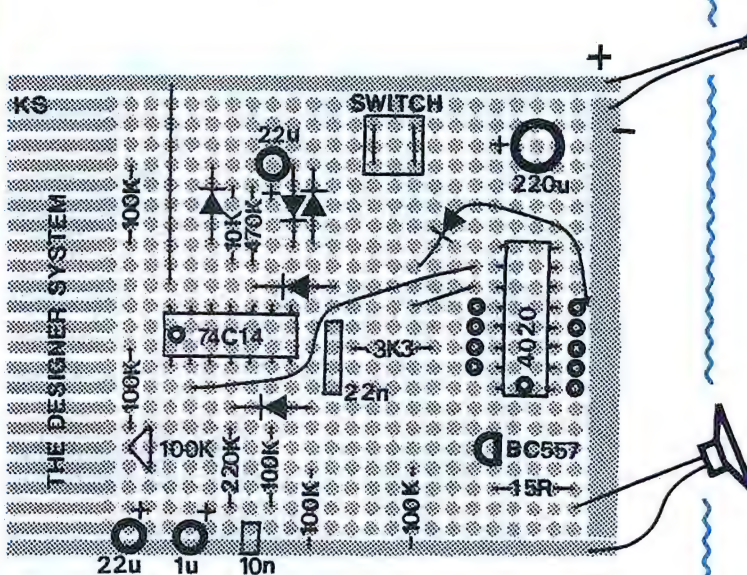
## Parts List:

- 1 - 15R
- 1 - 3k3
- 1 - 10k
- 5 - 100k
- 1 - 220k
- 1 - 470k
- 1 - 100k mini trim
- 1 - 10n 100v
- 1 - 22n 100v
- 1 - 1mfd 16v
- 2 - 22mfd 16v
- 6 - 1N914 diodes
- 1 - BC 557
- 1 - 74c14 IC
- 1 - CD 4020B IC
- 1 - push switch
- 1 - battery snap
- 10 - Molex pins
- 1 - speaker 8 ohm

# PHASER GUN

## Parts List:

- 1 - 6k8
- 1 - 15k
- 2 - 18k
- 1 - 22k
- 1 - 39k
- 1 - 50k mini trim pot
- 1 - mini trim as switch
- 2 - 22n 100v
- 1 - 1mfd 16v
- 2 - 22mfd 16v
- 1 - 100mfd 16v
- 1 - 220mfd 16v
- 4 - BC 547
- 2 - BC 557
- 2 - 5mm red LEDs
- 1 - speaker 8 ohm
- 1 - battery snap
- 1 - push button
- 2 - 220R
- 1 - 470R
- 1 - 1k2
- 1 - 2k2





# PROGRAMMABLE COUNTER WITH AUTO RESET

The programmable counter featured in issue 6 proved to be very popular. Many readers wrote in for the kit with PC board and judging by the letterheads, some were in the industrial electronics field.

After receiving his kit, one customer called into the office with a request for a modification so that his unit could be reset after a particular count had been reached and at the same time, an audible warning would be produced to let the operator know that the count had been reached.

In this circuit we have designed a simple add-on to provide this feature.

It consists of two 555 timers. The first IC detects a LOW on the collector of the buffer transistor on the Programmable Counter board, to start the timing cycle. This IC then sends out 2 separate signals. One signal comes from pin 7 to reset the three 4017 counter ICs and the other signal emerges from pin 3 to start the tone oscillator.

Pin 7 is normally sitting LOW and when pin 2 is brought low, it goes HIGH and resets the three decade counter chips, via the 10nF capacitor. This is classified as a feed-back line and will reset the counters instantly. This signal will remove the HIGH on the three gating diodes and produce a HIGH on the collector of the buffer transistor. The LOW on pin 2 will be removed but it will have already performed its task of setting the 555 timer into operation.

The output of the timer at pin 3 is directly connected to the second 555 chip via a TEST LINK. These links are very hand for isolating the stages and we specifically mention removing this link in the test section.

The second IC is wired as a gated oscillator. When pin 4 is HIGH, the chip will oscillate. By taking pin 4 LOW, the oscillator will stop. The output of the oscillator feeds a speaker via a 100mF or 220mF electrolytic. The frequency of the tone can be adjusted via the trim pot. And the duration of the tone can be lengthened or shortened by adjusting the timer trim pot.

Neither of these adjustments will affect the counting operation.

To add versatility to the project, we have added a 7805 regulator and a bridge rectifier to make a small power supply on the board. It will be

capable of supplying 100 to 200mA @9v to drive the counter and any external amplifier up to 5 watt, such as the simplicity amplifier. For short periods of time, the amplifier can be supplied without having the regulator heat-sinked. If you increase the signalling duration, the regulator will need a heat-sink.

If you intend to use the counter as an alarm, a Sonalert can be used and it is connected directly between pin 3 of the oscillator chip and ground. But since these have such a nasty high pitched squeal, it is not suggested for continual use.

One modification will need to be made to the original Programmable Counter PC board, before connecting the AUTO RESET PC board. The top 330k resistor from the base to the three gating diodes, will need to be changed to a diode so that the collector of the buffer transistor turns on hard when the gating diodes receive a HIGH. This will provide a guaranteed LOW for the timer.

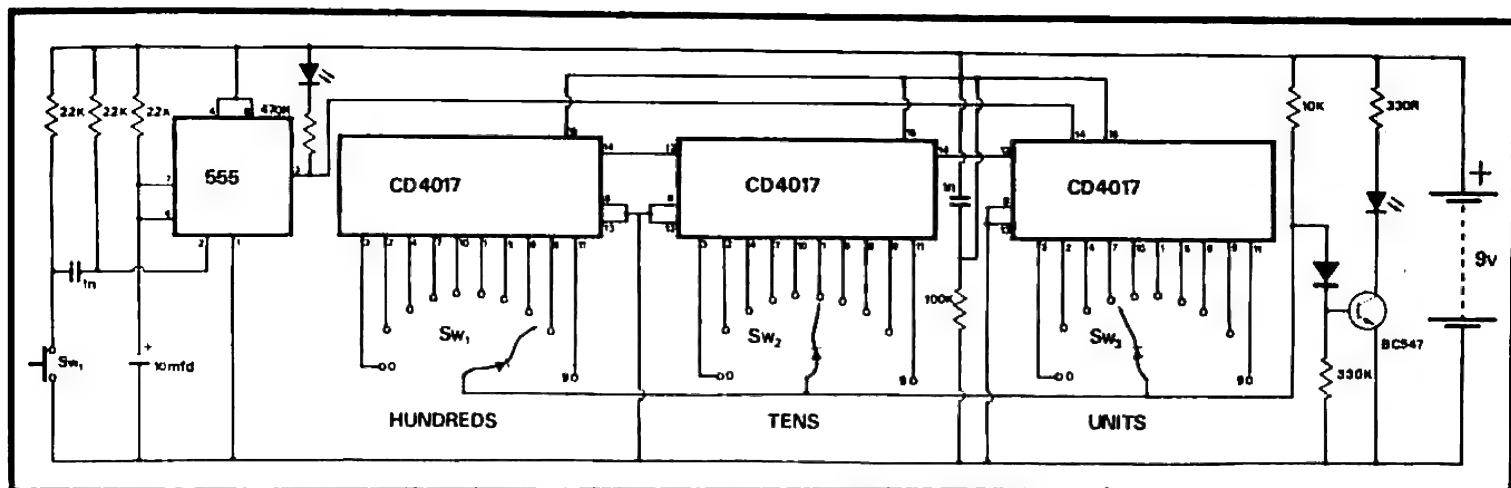
If you look at the circuit diagram carefully, you will see that the voltage on the anodes of the gating diodes is .6v, when the cathodes are at zero potential. This voltage is called a "set" voltage and if it were directly coupled to the buffer transistor, it would be turned on all the time. To prevent this, we insert a diode in the line. The diode will remove the set voltage and leave the base with a zero voltage. When a HIGH appears on all the gating diodes, this will allow the voltage supplied by the 10k resistor to rise and turn on the buffer transistor.

The 22k resistor on pin 2 provides a HIGH for pin 2 when the buffer transistor is not turned on. Otherwise the impedance at the collector would be extremely high since the LED provides almost an open circuit until it 'fires'. This would result in random triggering and false timing due to an open pin 2.

Two unusual component markings on the circuit diagram are labelled 100k with 4k7 stop and 100k with 10k stop. These are 100k mini trim pots, wired as variable resistors with a 4k7 fixed resistor inserted into one line, so that the resistance will not reduce down to zero.

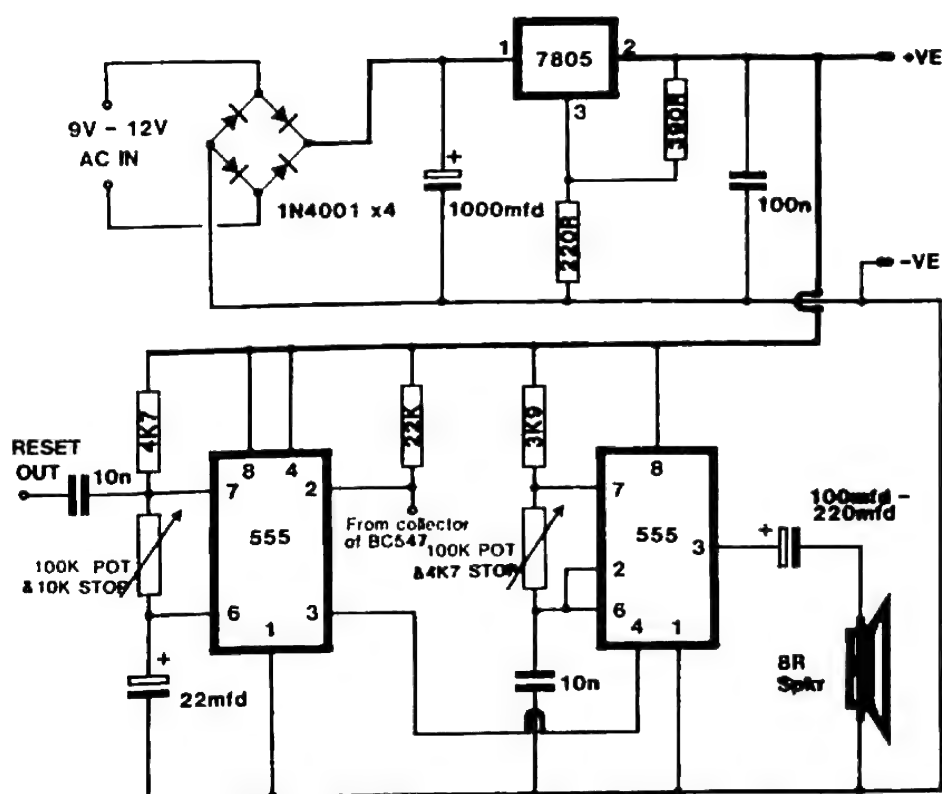
The AC terminals require 9v to 15v AC. I suggest using a low current plug pack of the special AC type. These can be connected directly to the AC terminals of the project. This





PROGRAMMABLE COUNTER CIRCUIT

The PC board and components can be used with only one modification. The 330k resistor feeding the base of the buffer transistor is replaced by a diode. Use this article in conjunction with the first part in issue 6. The three semi-circles of matrix pins can be replaced by three rotary switches if the counter is to be continually reset to different numbers.



AUTO RESET CIRCUIT

The diagram includes a power supply section to make the counter completely independent. You only need an AC PLUG PACK and the project is complete.

#### PARTS LIST:

- 1 - 330R
- 1 - 470R
- 1 - 10k
- 3 - 22k
- 1 - 100k
- 2 - 1n 100v
- 1 - 100mfd 16v
- 1 - 555 timer IC
- 3 - CD 4017 IC
- 1 - BC 547
- 3 - 1N 914 diode
- 2 - 5mm red LEDs
- 1 - push switch
- 30 - Molex pins
- 1 - battery snap

#### AUTO RESET PARTS LIST

- 1 - 220R
- 1 - 330R
- 1 - 3k9
- 4 - 4k7
- 1 - 10k
- 1 - 22k
- 2 - 10n 100v
- 1 - 22mfd 16v
- 1 - 220mfd 16v
- 1 - 1000mfd 25v
- 1 - 1N 914 diode
- 4 - 1N 4002
- 2 - 555 timer IC
- 1 - 7805 regulator

saves wiring up the live side of a power transformer and removes the danger in trying to hide the 240v wiring.

Plug packs are classified as double insulated and come as a sealed unit. This means you have very little chance of getting a shock from the transformer and it can be safely used by junior experimenters.

At first they may seem expensive, but because the final assembly is carried out in Australia, we must pay the price. If you look at the safety angle, they are well worth the slight additional cost.

The 7805 has been wired to give an output of .9v. This is achieved through two voltage divider resistors increasing the voltage on the common terminal.

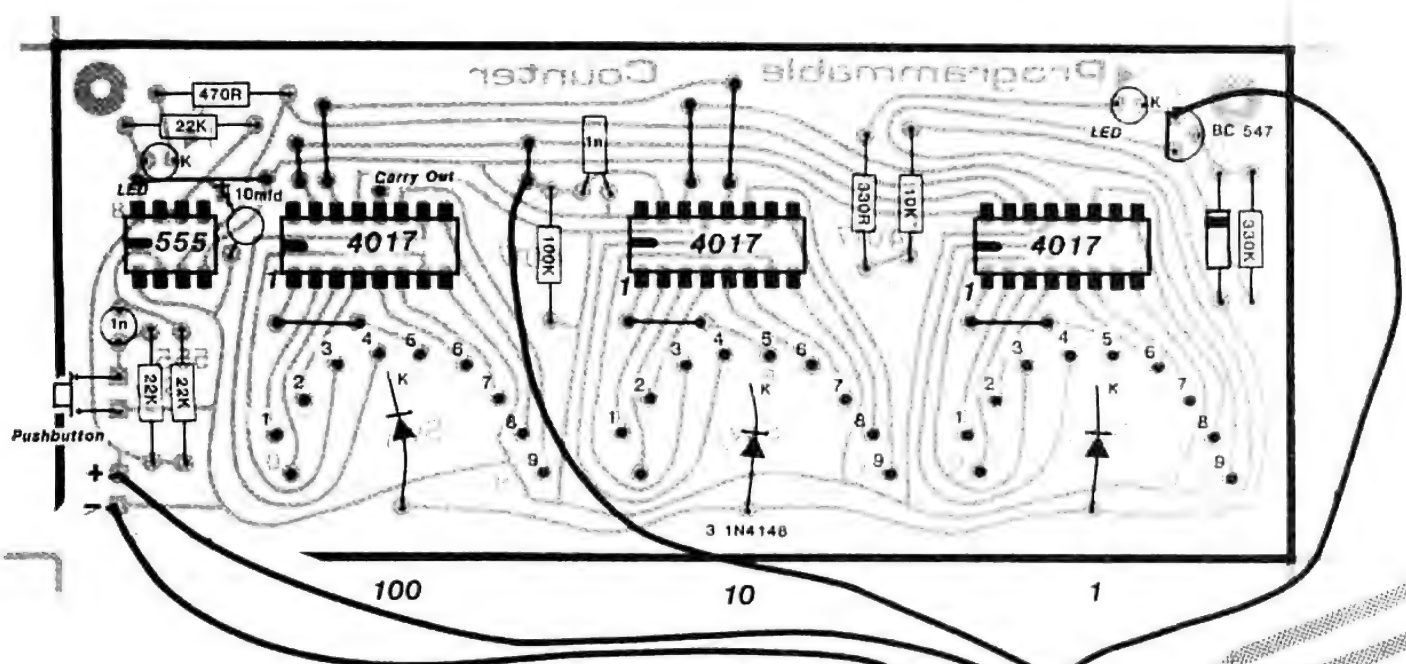
Both boards are the same width and can be fitted on top of one another via stand-offs or long screws. This will make a rigid construction which can then be mounted in a large box.

## TESTING THE CIRCUIT

When the power is applied, the oscillator will beep to indicate all is operational.

We are assuming that the Programmable Counter portion is operating successfully. The only portion to be tested is the Auto Reset section.

Choose a small number on the counter and press the push-button the exact same number of times. This should result in a beep for 1/2 sec to 2 seconds and the counter should be reset.



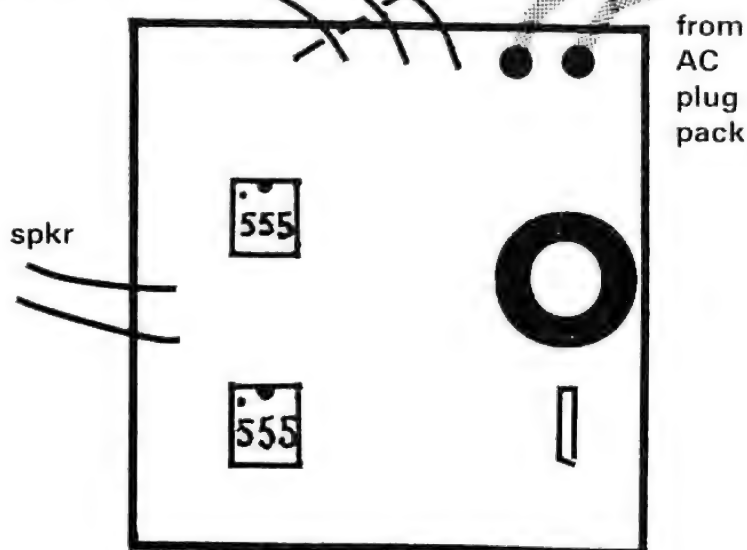
## FITTING THE COMPONENTS

No special precautions are needed when fitting the parts. The ICs are rugged and do not need sockets. But you must take care when inserting them into the board so that pin 1 matches the identification on the board.

The parts can be inserted in any order but I find it is best to start from one end of the board and work across in an orderly fashion.

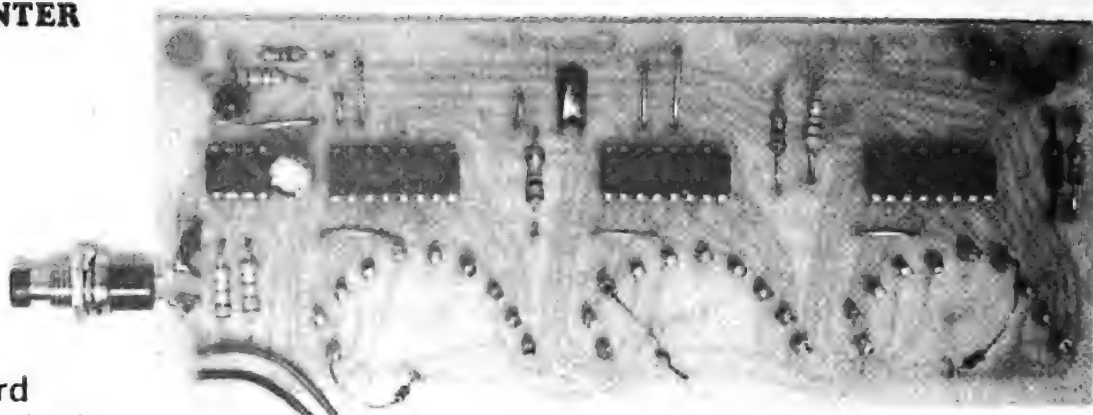
The AC input terminal accepts 9v to 15v. Use a plug-pack as suggested in the notes to avoid any 240v hazard.

Four jumper leads connect between the two boards. Two of these leads supply the power to the main board. One lead provides reset and the other carries the trigger pulse from the buffer transistor to the Auto Reset section. Refer to the wiring diagram for the position of these four leads as the main PC board does not have any identification points.

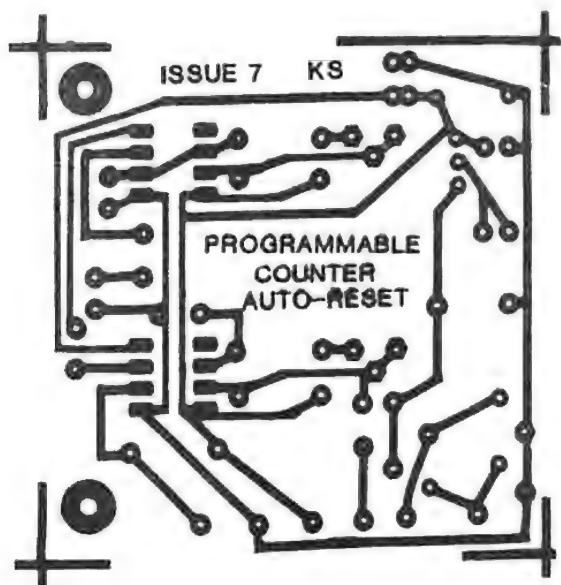
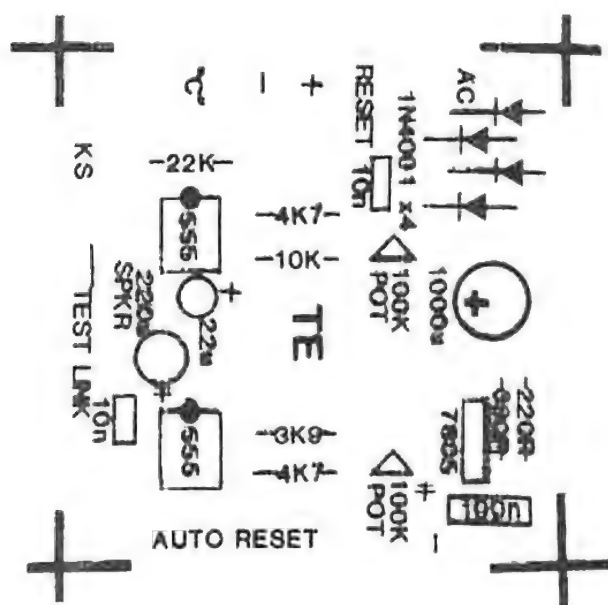


Connecting the reset PC board to the counter PC board. A plug pack supplies the unit and is fed into the AC input.

## PROGRAMMABLE COUNTER WITH AUTO RESET



The counter PC board showing the diode replacing the 330K resistor.



ready for the next counting operation. Check that the counter has been reset by following through the same operation again. Select a higher number involving the three counter chips and repeat the test.

If the speaker fails to respond, you will need to check each 555 individually.

Begin with the oscillator chip.

Remove the test link and take pin 4 HIGH. This will start the oscillator to give a continuous tone. If no sound results, check the capacitor and two resistors in the timing circuit. All you can do is physically check that they are correctly soldered. If the circuit still fails to oscillate, the chip may be at fault. If the circuit oscillates correctly, it can be turned off by taking pin 4 LOW. Refit the link.

### TESTING THE TIMER IC

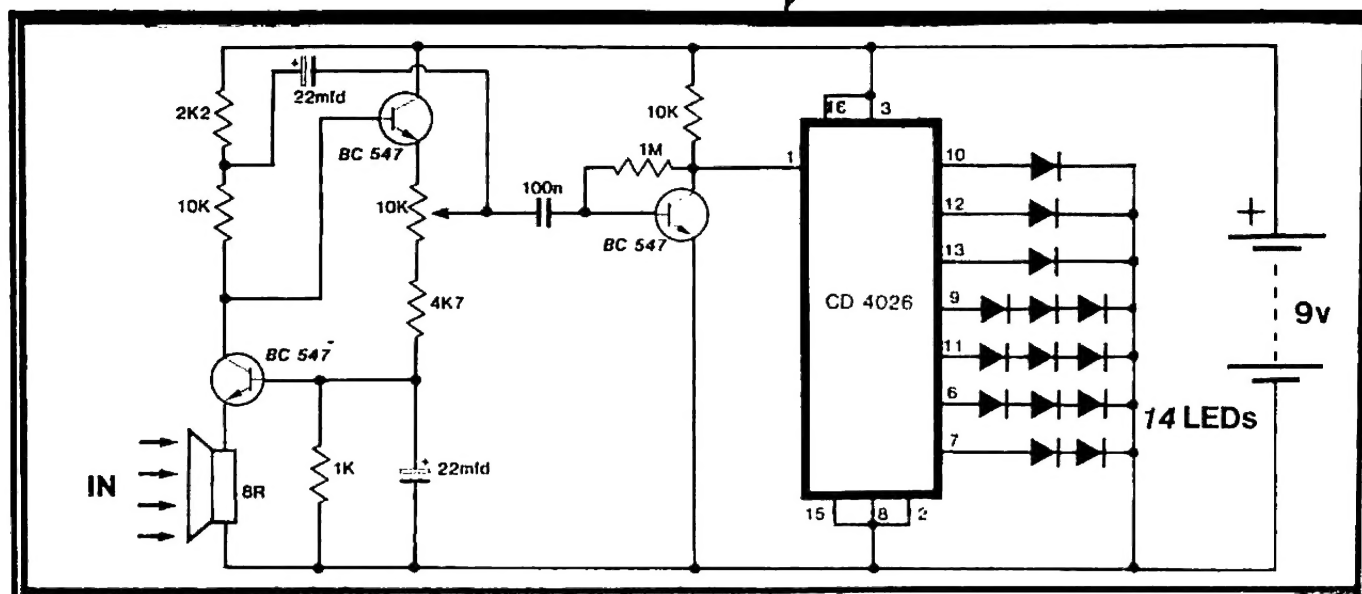
For the timer IC to operate correctly, pin 2 must change from a HIGH to a LOW. The LOW must be very near to zero voltage. For this reason, the buffer transistor must be turned on hard and not partly turned on. To simulate the effect of the buffer transistor, use a jumper lead connected to earth, for the zero potential. Touch pin 2 with the jumper and detect the timing cycle. If this 555 does not turn on the oscillator chip, you should look at the timing components for good soldering. If you have a multimeter, you can detect a rising voltage on the electrolytic as it begins to charge. Otherwise the only component is the chip itself.



This counter is the first of our industrial projects and will take a lot of the effort out of counting components. You will be able to adapt it to many situations. I hope you find it to be satisfactory in operation.



# MUSIC COLOUR



## MUSIC COLOUR CIRCUIT

The psychedelic effect of disco lights and the rhythmic synchronisation of light and sound . . that's what you get when you combine a disco lighting system with a music colour machine.

Now you can have this effect at home. Our MUSIC COLOUR project is a miniature version of a disco lighting system.

In this project, Ken and Ian have combined their talents to produce an extremely simple circuit. A single chip is used to drive an array of 14 LEDs. The LEDs turn on and off in a seemingly random pattern to produce an enormous variety of patterns. These patterns seem to correspond to the beat and frequency of the music. You won't believe me if I say the effect is hypnotic. You'll have to build it to see what I mean. This project is so simple yet the effect is so startling. This is because the 4026 chip is really a number of building blocks in the one package. In simple terms, it accepts a train of pulses at its input terminal and converts them into a set of HIGHS and LOWs on a combination of its 7 output lines.

These lines contain either one two or three LEDs, so that when they are providing a HIGH output, a pattern of lights will be displayed on the screen. This will illuminate from 2 to 14 LEDs.

The 4026 has 10 separate sequences and these are clocked by the incoming signal. Depending on the strength of the signal and its frequency,

the clock rate will alter. Sometimes the sequence will pass so fast that it looks as though the LEDs are stopping on a new combination every time. It will be impossible to decipher any particular pattern or sequence for this unit and the effects which result when music is being detected are really startling.

It will appear as if the microphone and pre-amplifier are detecting 3 separate frequency ranges. It's really impressive. As the music increases in volume, the rate of change increases and simulates the 'high range' in a music-colour machine. The lower frequency range coincides with the pauses in the music.

Even though I state that the circuit is not frequency selective, your eyes will tell you differently. They will deceive you. And you'll accept the deception. It's that good.

While I prepare this article, I have my little unit sitting on top of a radio, with the sensitivity control turned fully down. It's picking up the sound of the music by the vibrations through the radio cabinet. With the room light turned off, the illumination of the LEDs can be fully appreciated. They are quite bright and as they form patterns in time with the music, you may ask yourself, "Why don't they add this feature to all disco radios?"

It's like producing your own sound and light show.

Ken has included 3 yellow and 3 green LEDs with the 8 red LEDs, to get a multi-coloured effect. And combined with Ian's diamond shape display, we get an array of calming, hypnotising patterns.

## ASSEMBLY

All the parts fit onto our printed circuit board and the overlay identifies each component and its orientation. If you are not completely skilled with a soldering iron and wish to avoid damaging the chip, the 4026 can be mounted in an IC socket. This is always a wise precaution. Especially when the chip is more expensive than a socket.

It won't take long to mount the components but if you want the display to look really impressive, you will need to put a little thought into the positioning of the various LEDs.

We suggest placing the green and yellow LEDs so that no two colours are adjacent to one another. This will give the greatest impact with the minimum number of the more expensive LEDs. All the LEDs face in the one direction and by looking into the body of each LED, you can identify the cathodes. Make sure they all sit upright in neat rows before soldering. The neatness of the display is most important. It won't look nice if any of the LEDs are out of line.

When fitting the other components you will have to take special care that they are also inserted around the correct way. The IC must be fitted so that the notch in the IC matches up with pin 1 identification on the printed circuit board overlay. The transistors are also marked on the board so that they cannot be inserted incorrectly. The board is marked with a flat on one side to correspond with the flat on the transistor. The electrolytics are printed circuit types and have both leads emerging from the one end. During manufacture, the positive lead is made longer than the negative lead. Check the layout before inserting any of these components. The only parts which can be inserted either way round are the resistors and green cap capacitor. The speaker can also be mounted either way round. The trim pot holes will take either a vertical or horizontal mounting pot. You may wish to go to the added expense of a cermet pot so that you can turn the sensitivity control up and down without having to use a screw-driver.

Complete the project by fitting a battery snap and 2 stiff leads to the speaker. This will allow the PC board to sit on top of the speaker as shown in the photo.

The unit can be positioned on top of a speaker box or in front of a radio. If you wish to have stereo Music Colour, you will need to build-up two units. This will be welcomed by our printed circuit board suppliers!

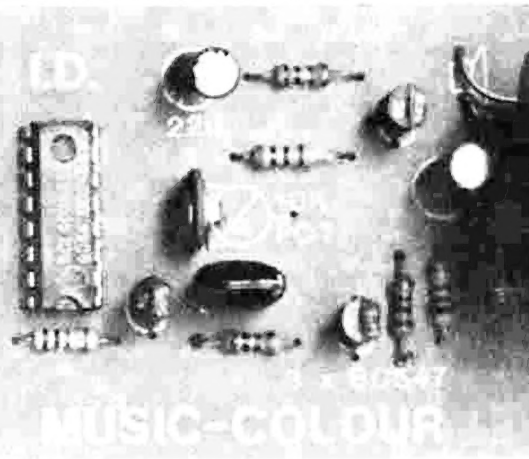
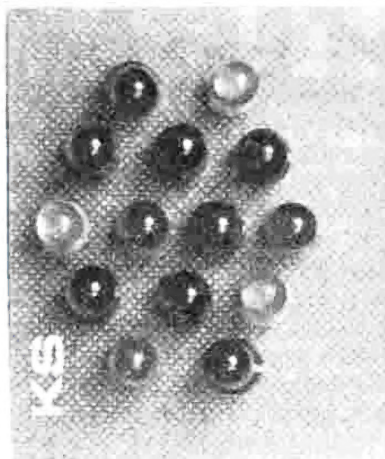
## HOW THE CIRCUIT WORKS

The first two transistors are wired as a BOOT-STRAP circuit. To understand how this section amplifies, you must consider the two transistors together. They cannot be separated. You cannot remove one transistor and expect the gain to be half. It would drop down to less than one-tenth! In our proto-type a loud whistle near the microphone produced about 2 millivolts from the speaker/microphone. This is about the maximum output of the moving-coil sensor and this voltage is supplied to the base of the first transistor. The output, after amplification by the first two transistors was 2v peak-to-peak. This means the amplification for the pair is 1,000 times. Our first question was: do both transistors amplify the signal or does one transistor provide most of the amplification? When we measured the output at the collector of the first transistor, we found it to be 2v p-p. This means the first transistor is providing all the amplification. The reason for this can be explained as follows: The second transistor is wired as an emitter follower. This means it cannot provide any voltage amplification (which we are measuring on the CRO) but it does provide current amplification and this enables the first transistor to operate more effectively.





Close-up  
showing  
all parts.



An emitter follower such as Q2, produces very little load on the first transistor and enables the full voltage swing to be amplified. But in our case it gets an assistance from the second transistor. The top 22mfd electrolytic provides positive feed-back since the input and output of an emitter follower are in phase. This feedback signal modifies the voltage on the 10k resistor and the first transistor thinks it is producing this voltage. Thus the electrolytic tends to pull up or INCREASE the voltage produced by the first transistor and the second transistor allows it to be passed to the variable pot. The electrolytic provides only AC positive feedback and the DC operating conditions of the circuit are not affected.

The third transistor is AC coupled via the 100nF capacitor. On our proto-type a 30mV input to this stage produced a 3v p-p output on the collector. This converts to a gain of 100 times. Thus the overall gain of the 3 stage amplifier is 10,000. Quite a high gain for such a simple circuit. This explains the extreme sensitivity of the dynamic microphone.

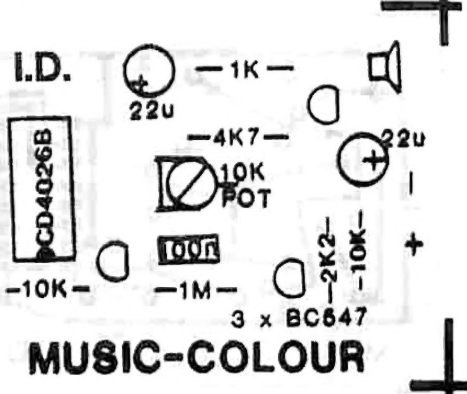
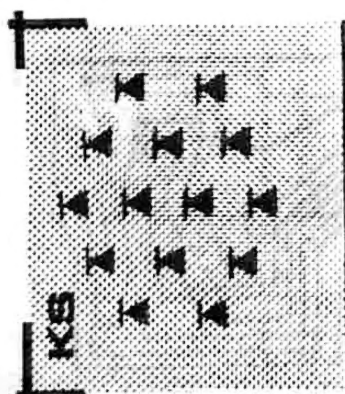
The output of the amplifier appearing at pin 1 of the 4026 will contain an assortment of wave-forms according to the music being picked up. The IC will clock when ever any of these has an amplitude greater than half the supply rail voltage. The result will be periods of fast clocking combined with slow clocking to give a seemingly random pattern. The whole object of the arrangement of the LEDs is to disguise the decoded outputs of the 4026 to give a non-interpretal pattern. And this I think we have achieved.

## PARTS LIST

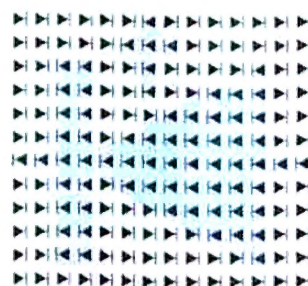
- 1 - CD 4026 IC
- 3 - BC 547 transistors
- 8 - 5mm red LEDs
- 3 - 5mm green LEDs
- 3 - 5mm yellow LEDs
- 1 - 1k 1/4 watt
- 1 - 2k2
- 1 - 4k7
- 2 - 10k
- 1 - 1M
- 1 - 100nF greencap 100v
- 2 - 22mfd 16v PC electro
- 1 - 10k pot
- 1 - 8 ohm speaker
- 1 - battery snap
- 1 - 9v battery

## EXTENDING THE MUSIC COLOUR

The Music Colour can be arranged to drive small torch globes by fitting a set of 7 buffer transistors between the outputs of the 4026 and the LEDs. This can be extended to driving 15 to 100 watt globes by using a set of triacs as the high voltage switches. However this is outside the scope of this magazine. We will not be producing and live-mains projects at any stage. So you will have to be content with small globes or LEDs.



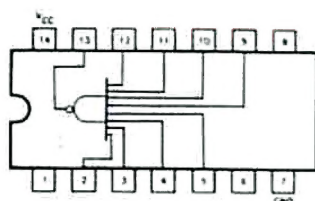
Did you find the LED?



Join all diodes facing this direction: ◀

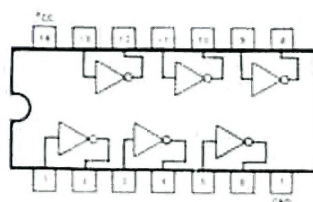


CD4068



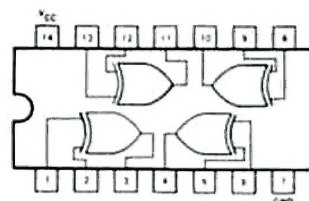
8-INPUT NAND GATE

CD4069



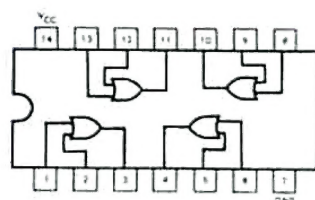
HEX INVERTER

CD4070



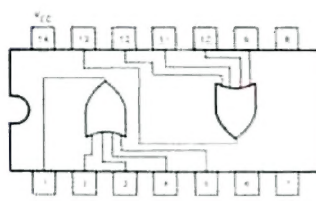
QUAD EXCLUSIVE OR GATE

CD4071



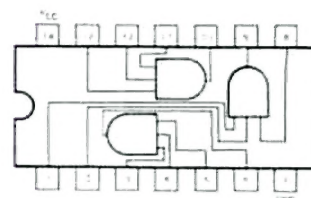
QUAD 2-INPUT OR GATE

CD4072



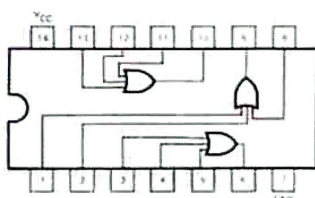
DUAL 4-INPUT OR GATE

CD4073



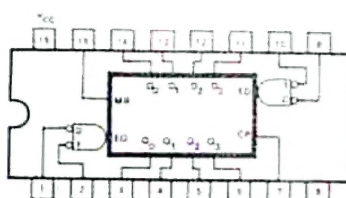
TRIPLE 3-INPUT AND GATE

CD4075



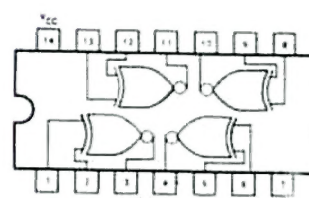
TRIPLE 3-INPUT OR GATE

CD4076



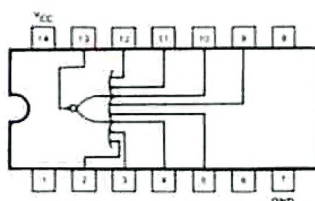
QUAD D FLIP FLOP WITH 3-STATE OUTPUT

CD4077



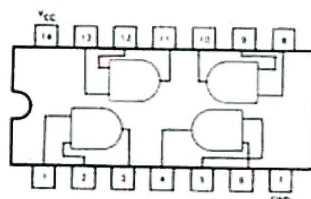
QUAD EXCLUSIVE NOR GATE

CD4078



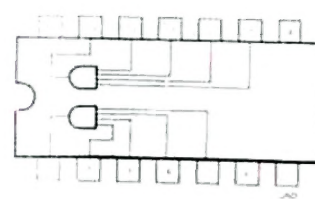
8-INPUT NOR GATE

CD4081



QUAD 2-INPUT AND GATE

CD4082



DUAL 4-INPUT AND GATE